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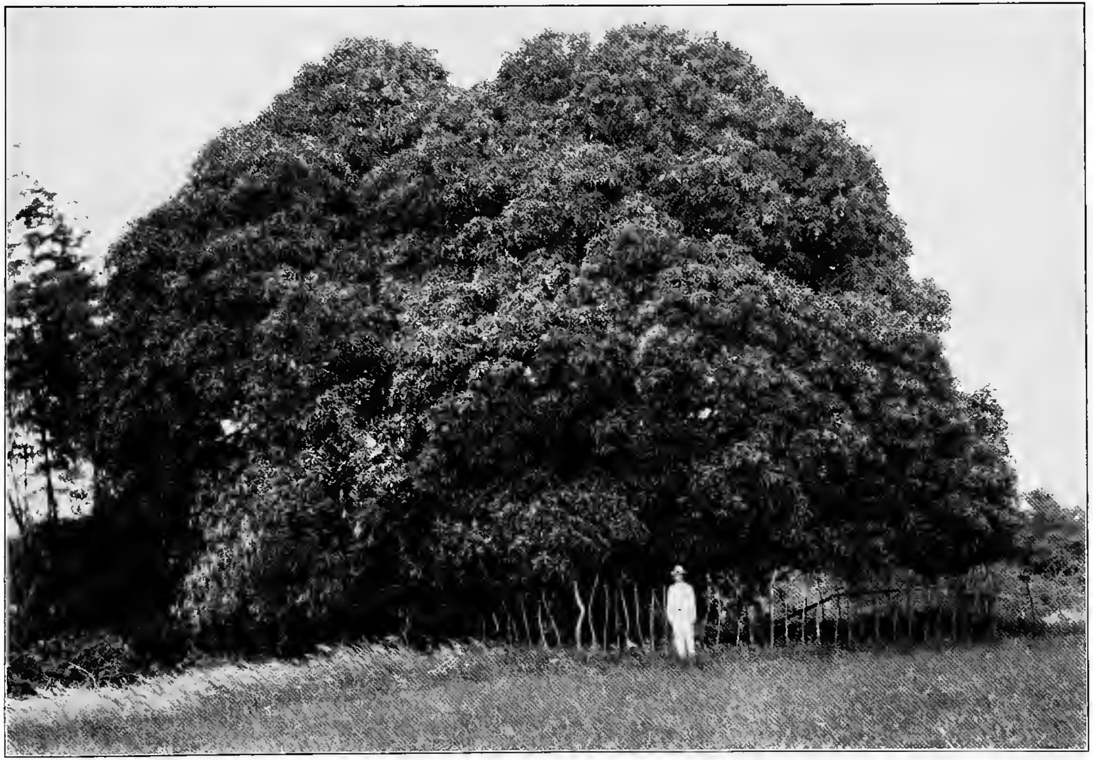
PLATE I.



MANGO TREE IN THE PHILIPPINES: "PAHUTAN" SEEDLING.

THE GOVERNMENT OF THE PHILIPPINE ISLANDS
DEPARTMENT OF PUBLIC INSTRUCTION
BUREAU OF AGRICULTURE
FREDERIC W. TAYLOR, DIRECTOR OF AGRICULTURE

BULLETIN NO. 18

THE MANGO

BY

P. J. WESTER
Horticulturist

UNDER THE SUPERVISION OF

OTIS W. BARRETT
Chief, Division of Experiment Stations

MANILA
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LETTER OF TRANSMITTAL.

MANILA, *November 7, 1911.*

SIR: I have the honor to transmit herewith manuscript for a bulletin on "The mango," and to respectfully recommend publication thereof as Bulletin No. 18 of the Bureau of Agriculture. This manuscript has been prepared by Mr P. J. Wester, horticulturist of this Bureau.

The subject matter of the manuscript bears particularly on Philippine conditions, yet it should be of great interest to mango propagators and producers throughout the world. This is the first time a work has appeared on this subject giving a clear and concise résumé of the history of the introduction and culture of this fruit, with complete bibliographical references. Several distinctly new features of mango propagation are brought out; and it is believed that the publication of this manuscript will mark a new epoch in Philippine mango production.

Very respectfully,

O. W. BARRETT,
Chief, Division of Experiment Stations.

F. W. TAYLOR,
Director of Agriculture, Manila, P. I.

Publication recommended
F. W. TAYLOR, *Director.*

Publication authorized
NEWTON W. GILBERT,
Secretary of Public Instruction.

THE MANGO.

INTRODUCTION.

The most popular dessert fruit in the Philippines is undoubtedly the mango and deservedly so. The mangosteen may be more delicately flavored but it lacks the almost luscious richness of flavor and aroma of the mango; moreover it is more difficult of cultivation than the mango, of slow growth and its season short, hence it has never secured the hold on the esteem of the people as the mango, which grows everywhere in the Islands with the freedom and luxuriance of a forest tree, attaining under favorable conditions dimensions that few of these surpass. The superiority in flavor of the best Philippine mangos over those grown in other countries is well recognized.

Long cultivated in India, where it is considered one of the choicest of the fruits there, and where numerous varieties have been cultivated for centuries, the mango was probably introduced into the Philippines in the first half of the seventeenth century. The propagation and dissemination of the mango in both hemispheres, except in India, have been effected almost exclusively by means of seeds until within the last two decades. The many successful importations of grafted plants from India into the United States have greatly stimulated the interest in the cultivation of the mango in south Florida, Porto Rico, and Cuba, with the result that after many attempts, a method of propagating the mango has been worked out in Florida that is believed to be of the greatest importance in the propagation of this fruit, and budded trees are now being planted out in greater numbers in these countries than probably anywhere else. Superior mangos have also been introduced into Hawaii from India and the Philippines.

The widely different regions of the United States where the mango can be successfully cultivated each possess advantages and disadvantages peculiar to their location.

Generally speaking the tropical possessions are favored with better soil and by immunity from damage by injurious or destructive frosts or freezes to which young tropical trees are subjected even in south Florida and California during the winter months if they are not protected. With these disadvantages Florida and California have advantage of being in close proximity to the great market of the United States. Not until progress in steam navigation has made even greater strides in the future than it has accomplished in the past, may the Philippines expect to export mangos to the North American continent. However, with the great undeveloped trade with Hongkong and the great seaports of China and Japan, with their large population and immense passenger traffic, not to speak of Manila itself, the Philippines have a very good market at home, and properly exploited a good market for the Philippine mango might well develop in Australia.

A steadily increasing need for information in regard to the mango and its culture is making itself felt but the literature on the subject is widely scattered in books and periodicals, practically inaccessible to most mango planters. To meet this want is the aim in preparing this bulletin, which is largely based on the experience obtained in six years' study of the mango in south Florida, where the writer was connected with the subtropical laboratory and garden maintained by the United States Department of Agriculture, complemented by seven months' stay in the Philippines.

Several of the descriptions of the varieties from India have been prepared with the aid of material in the Office of Pomology, United States Department of Agriculture, for access to which the author wishes to acknowledge his indebtedness to Mr. William A. Taylor, Assistant Chief, Bureau of Plant Industry, and Colonel G. B. Brackett, Pomologist in Charge of Pomological Collections in the same Bureau. In the discussion of the insects affecting the mango, the author has been very materially aided by the use of the notes on this subject collected by Mr. J. G. Sanders, entomologist of the University of Wisconsin, Madison, Wisconsin, and by the suggestions of Mr. E. R. Sasscer, Bureau of Entomology, United States Department of Agriculture, who has reviewed the pages relating to entomology. Several passages relating to the mango contained in works in Latin, Spanish, and Portuguese have been translated by Dr. Audrey Goss, late of the Bureau of Plant Industry, United States Department of Agriculture. Much of the merit the bulletin may possess is due to Mr. O. W. Barrett, chief, division of experiment stations of this Bureau, who reviewed the manuscript before going to press. Plates VII, VIII and IX are from photographs taken by the author and his associates in Miami, Florida, and are, together with Plates II and VI, published through the courtesy of Mr. David Fairchild, Bureau of Plant Industry, United States Department of Agriculture.

NOMENCLATURE, ORIGIN, GEOGRAPHICAL DISTRIBUTION, AND REFERENCE TO THE MANGO IN LITERATURE.

The antiquity of its cultivation among many peoples with widely different languages has vouchsafed to the mango a great variety of names. The name "mango" is, according to Crawfurd, a corruption of the Malay name "mangga." [1]

In Sanscrit it is amra and mahapahla, which latter name means "great fruit." [2] The mango is the "an-mo-lo" of Hiouen Thsang, the "anba" by Ebn Batuta, the "aniba" of Jordanus and the "amba" of Varthema and Conti, which is also its name in Hindustani and Singhalese; among other names are, in Bengali am; Tamil, mangas marum;[3] Burmese, that-yat; Chinese, mang-kwo; Javanese, palam; Arabian, maghzak;[4] Persian, amb or amba.[5] Many other names might be mentioned.

The mango is considered sacred by the Hindus. Its flowers are employed in their worship of Shiva; and the plant is inextricably connected with their mythology and folklore, as shown by the following typical quotation:

> "The daughter of the Sun was persecuted by a sorceress, to escape from whom she transformed herself to a golden lotus. The king fell in love with the flower, which was burnt by the sorceress. From its ashes grew a mango tree, and the king fell in love first with its flowers, and then with its fruit. When ripe, the fruit fell to the ground, and from it emerged the daughter of the Sun, who was recognized by the king as his lost wife."

According to De Candolle [6] the mango is indigenous to south Asia or the Malay Archipelago, and is reported to grow wild in Ceylon and at the base of the Himalaya Mountains. In India it is grown as far north as 30° latitude, and from sea level to an altitude of 4,000 feet.[7] As indicated by the names in Sanskrit and references to the mango in Indian mythology, the cultivation of this tree is very ancient in India. De Candolle,[8] although with a question mark, places the mango among the plants considered to have been in cultivation for four thousand years.

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[1] Crawfurd, J., Indian Archipelago, 1820, Vol, I, p. 425.

[2] Ibid, p. 423.

[3] Pickering, C., Chron. Hist. of Plants, 1879, p. 237.

[4] Balfour, E., Cyclop. of India, 1885, p. 846.

[5] Rumphius, G. E., Herb. Amboiense. 1741, Vol. I, p. 95.

[6] De Candolle, A., Origin of Cultivated Plants, 1885, p. 200.

[7] Balfour, E., Cyclop. India, 1885, Vol. II, p. 846.

[8] De Candolle, A., Origin of Cultivated Plants, 1885, p. 441.

The Chinese traveler, Hiouen Thsang, who visited Hindustan between 632 and 645 A. D., seems to be the earliest traveler to refer to the mango.[9] By travelers from the west it is first mentioned under the name of "ambag" by Ebn Haukal, who probably lived between 902 and 968 A. D. Later travelers who noted the mango are the friar Jordanus Catalani, who described it in his Mirabilia Descripta, written about 1330 A. D. Ebn Batuta, visiting India in 1325 to 1349, speaks of the mango as a product of the Indian Archipelago.[10] Nicolo Conti, between 1419 and 1444, noted the mango in Malabar,[11] and Ludovici de Varthema, 1503 to 1508, in "Calicut." The first observations of the mango in Java appear to have been made in 1595 by Hollandish travelers in the East Indies.[12]

What is probably the earliest illustration of the mango was made by Acosta,[13] illustrating the plant in bloom and fruit. He speaks of the mango as growing in "Malabar, Guoa, Guzarate, Balagate, Bengala, Pegun, Malakka, and Ormuz." Later it was described and illustrated by Linschoten,[14] and it is also mentioned by Pyrard,[15] who traveled in India in the early part of the seventeenth century.

In India the choice varieties have long been in cultivation. Abul Fazl (about three hundred years ago) described a large number of cultivated races and speaks of a variety, the tree of which was "not so high as the ordinary stature of a man," showing that the creeping varieties were already then in existence.[16] The Alfonso, one of the most celebrated of the Indian varieties, of which there are several strains, is said to have obtained its name from Alfonso Albuquerque, the second Viceroy of Goa, who died in 1515,[17] and David Fairchild, who has traveled extensively in search of choice mangos for importation into the United States, states that the Douglass Bennett Golden Alphonse was grafted 130 years ago by a Parsee merchant. Rumphius[18] records mangos weighing over 2 pounds having very small seed and being nearly fiberless. Raffles,[19] visiting Java in 1811, states that at least forty varieties were then grown there. Delicious mangos are grown in Siam, and over 1,000 hectares are devoted to the cultivation of the mango in Cochin China; those grown at Singapore are said to have an intense terebinthine flavor.[20]

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[9] Pickering C., Chron. History of Plants, 1879, p. 237.

[10] Birdwood, G., Rep. The Old Records, India Office, 1891, p. 111.

[11] Hakluyt Soc. India, Fifteenth Century, 1857, Vol. II, p. 19.

[12] Hakluyt, R., Voyages, 1598, p. 228.

[13] Acosta, C., Tractado de las Drogas, 1578, p. 316.

[14] Linschoten, J. H. van., Navigatio Ac. Itinerarium, 1599, pp. 59–61.

[15] Pyrard, F., Voyages, 1679, Pt. III, p. 18.

[16] Watt, G., Dic. Ec. Products of India, 1885, Vol. V, p. 153.

[17] Jour. Agri. Hort. Soc. India, 1842, p. 267.

[18] Rumphius, G. E., Herbarium Amboiense, 1741, Vol. I, p. 94.

[19] Raffles, T. S., History of Java, 1830, 2d ed., p. 41.

For a plant so long in cultivation, with a fruit so attractive and useful, the dissemination of the mango outside of its native countries was surprisingly slow. West of India the mango was introduced into Yemen, Arabia, in the latter part of the fifteenth century [21] but was still rare after the middle of the eighteenth.[22] In 1331 it was seen on the coast of Somaliland by Ibn Batuta,[23] but the subsequent distribution of the tree in tropical Africa proceeded exceedingly slowly. In Mozambique there exists a tradition that the mango was introduced there by the Jesuits,[24] at what date is not suggested. To the west coast of Africa it was probably introduced by the Portuguese. It is curious to note that, according to Livingstone and Monteiro, the natives in certain parts of Africa consider the planting of a mango an act of evil omen, and think that it will be followed by death.[25] It was grown largely in Reunion after the middle of the eighteenth century.[26] Boyer [27] enumerates fifty-five different sorts grown in that island. It is surprising to note that only recently has the mango been introduced into Madagascar.[28] The mango was cultivated in Madeira early in the nineteenth century,[29] while as late as in 1866 it was yet seldom seen in the Canaries or Cape Verde Islands.[30]

It was introduced into southern Italy in 1905, where it promises to succeed well, and was introduced into the Azores in 1865, but the fruit produced there, as well as in Madeira, is inferior to that grown on the African continent.

In the Iberian Peninsula the mango has found a congenial climate in lower Estramadura, Portugal,[31] where it has recently been introduced. Southern France is evidently too far distant from the Tropics, for its introduction there has not been successful. It was reported as being cultivated under glass in

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[20] Simmonds, P. L., Tropical Agriculture, 1899, p. 484.

[21] Hakluyt Soc., 1863, Vol. 32, p. 161.

[22] Forskal, Flora Aegypt-Arab., 1775, p. 205.

[23] Engler, A., Die Pflanzenwelt, 1895, Vol. V, Theil B, p. 201.

[24] Peters, W., Reise nach Mossambique, 1862, Vol. I, p. 90.

[25] Figalho, de Conde, Plantas Uteis Africa Portugueza, 1884, p. 124.

[26] Bernadin de St. Pierre, J. H., Voyages, 1775, p. 122.

[27] Boyer, W., Hortus Mauritianus, 1837, p. 73.

[28] Heckel, E., Les Plantes Méd. Madagascar, 1903, p. 70.

[29] Bowditch, T. E., Excursions in Madeira, 1825, p. 166.

[30] Jour. Roy. Hort. Soc., new ser., 1866, Vol. I, p. 167.

[31] Reclus, E., The Earth and its Inhabitants, Vol. I, p. 487.

Hampton Court in 1690,[32] and was fruited at Kew in 1808.[33] In the East, Rumphius states [34] that it was introduced to the Molukkas in 1655, though the variety of native names would seem to indicate a more ancient introduction.

In Australia the mango was naturalized in New South Wales over fifty years ago [35] and probably also in Queensland, where it luxuriates along the coast.

In the Western Hemisphere the mango seems to have been first introduced into Brazil, at what date is unknown. From here it was brought to Barbados about 1742 or 1743.[36]

In Jamaica the mango was introduced in 1782, when Captain Marshall of Lord Rodney's squadron captured a French vessel bound from the Islands of Reunion and Mauritius, to Santo Domingo, having on board many valuable plants, among which was the mango, said to have been in the form of grafted stock.[37] The first attempt by the colonial government of Jamaica to introduce grafted India mangos was made in 1869, when twenty-two varieties were received in Wardian cases, via Kew, England.[38] Notwithstanding this, and several subsequent introductions of choice varieties to the island, it seems that the majority of mango trees in Jamaica are still seedlings and that the dissemination of the better varieties has been exceedingly slow. In fact, a recent writer says that practically every mango tree in Jamaica is a seedling.[39] Numerous sorts are described growing in the several districts of the island, which, however, are evidently propagated from seed and should, on that account, be designated as types rather than varieties.[40]

The writer has found no records of the introduction of the mango into Mexico, but it was probably introduced rather early by the Spaniards from the Philippine Islands, from thence it subsequently found its way to Cuba. Abbot [41] speaks of "two kinds of mangos, by some esteemed to be the finest fruit on the island." Pittier [42] says that according to some, the mango was first introduced into Costa Rica in 1796, together with coffee and cinnamon, while others assert that its introduction was delayed until 1830, when seeds were brought over from Cuba. The probability is that several distinct introductions were made during this period from different sources and to different parts of the Republic. It is now more or less common in all parts of tropical America.

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[32] Aiton, W., Hortus Kewensis, 1789, Vol. I, p. 278.

[33] Trans. Hort. Soc. London, 1820, Vol. I, p. 151.

[34] Rumphius, G. E., Herbarium Amboiense, 1741, Vol. I, p. 95.

[35] Bennett, G. A., Naturalist in Australia, 1860, p. 338.

[36] Trans. Soc. for Encouragement of Arts, 1786, p. 217.

[37] Collins, G. H., U. S. Dept. of Agri. B. P. I., Bulletin 28, 1903, p. 12.

[38] Bull. Bot. Dept. Jamaica, 1901, Vol. VIII, p. 162.

[39] Bull. Dept. of Agri. Jamaica, 1909, new series, Vol. I, p. 49.

[40] Bull. Bot. Dept. of Jamaica, 1901, Vol. VIII, p. 165.

[41] Abbot, A., Letters from the Interior of Cuba, 1829, p. 242.

[42] Pittier, H., Las Plantas Usuales de Costa Rica, 1908, p. 112.

The dissemination of the mango in most of the Pacific archipelagos has been very slow. It was apparently not yet introduced in Hawaii as late as 1865, not being included by Mann in his "Enumeration of Hawaiian Plants."[43] Pickering[44] did not find full grown plants at the time of his visit to Hawaii, and Horne[45] found the mango so recently introduced into the Fiji Islands that only a few had begun to bear when he visited the Islands.

In southern California the cultivation of the mango has so far not attained any prominence. According to F. Franceschi, the mango was first planted between 1880 and 1885 at Santa Barbara. More recently it has been planted at San Diego, Los Angeles, and Hollywood. It seems that the conditions there are not so congenial to the species as in Florida.

The earliest introduction of the mango into Florida appears to have been made in 1833 by Henry Perrine.[46] According to an extract from the postscript of a letter to the Secretary of the Treasury dated Campeche, Mexico, September 12, 1833, he sent to Florida *"Persea gratissima, Mangifera domestica* (*indica*) *Annona squamosa, Annona muricata, Mammea americana,"* etc., but after his death, in the massacre of Indian Key, the trees perished owing to neglect, war, and fire, and many years elapsed before another attempt was made.

The second and successful introduction was made to the lower east coast of the State by a Doctor Fletcher in Miami in 1861 or 1862, since which date many separate introductions have been made.

The most valuable introduction of mangos, by seed, was made in 1900 when Gary Niles shipped a barrel of "Manila" mangos from Havana, Cuba, to Miami, Florida, this being a polyembryonic type having fruit of excellent flavor, analogous in many respects to the "Carabao" type in the Philippines.

The first successful introduction of grafted mangos into Florida was made in 1889 by the division of pomology, United

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[43] Proc. Am. Acad. of Arts and Sci., 1868, Vol. VII, pp. 143–235.

[44] Pickering, C., Chron. History of Plants, 1879, p. 237.

[45] Horne, J., A Year in Fiji, 1881, p. 99.

[46] 25th Congress, 2d session, Rep. 564, 1838.

States Department of Agriculture, the variety being Mulgoba; a second introduction was made in 1899, and subsequently one after another importation followed until now the office of foreign seed and plant introduction of the Bureau of Plant Industry contains records of nearly 200 varieties, many of which are, however, duplicates or memoranda of introductions made independently of that office but presented to the Department of Agriculture.

The introduction of the mango into the Philippines is hereinafter considered in a separate chapter.

BOTANY.

The genus *Mangifera* (from "mango," Hindu name for the fruit, and "ferro," to bear) to which the mango belongs, contains, according to Engler and Prantl, twenty-seven species. The Index Kewensis enumerates thirty-seven species, all except two (*M. africana* Oliver, a native of West Africa, and *M. laxiflora*, of the Island of Mauritius) being indigenous to India and Malaysia.

The family *Anacardiaceæ* in which the genus *Mangifera* is included, contains several trees of economic value, of which may be mentioned the cashew (*Anacardium occidentale* L.), the pistache (*Pistacia vera* L.), the quebracho (*Loxopterygium lorentzii*), valuable for its timber and as a source of tannin, and the genus *Spondias*, of which several species are cultivated for their fruits.

Besides the mango, the genus *Mangifera* contains several other species—*M. cæsia* Jack., *M. fœtida* Lour., *M. oppositifolia* Roxb., whose fruits are relished by the natives in the countries in which they grow. The most valued of these is *M. fœtida*, a native of Cochin China, producing large fruits having a very offensive odor, resembling that of the durian.

The mango (*Mangifera indica* L.), is an evergreen tree that in cultivation varies in height from a tall shrub to a tree 15 to 20 meters high, with a trunk that sometimes is 1.5 meters or more in diameter. Very large trees exist in India; Woodrow[47] mentions a mango tree that measured "seventeen feet in circumference four feet from the ground." The leaves are alternate, stalked, linear-lanceolate, entire, coriaceous, 13 to 30 centimeters long, which bruised when they are young and tender emit an aromatic odor which varies considerably in the different types and varieties. The small, reddish-white, yellowish, or greenish polygamous flowers are borne on pubescent terminal panicles

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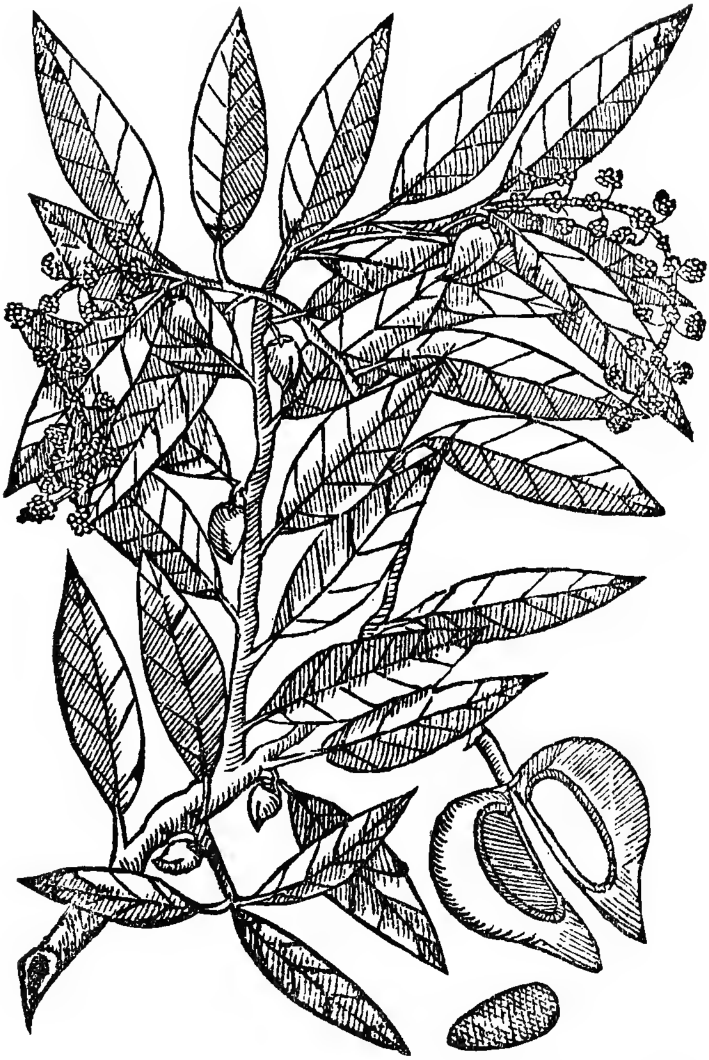
[47] Woodrow, G. M., The Mango, 1904, p. 7.

PLATE II.

316

Mangas.



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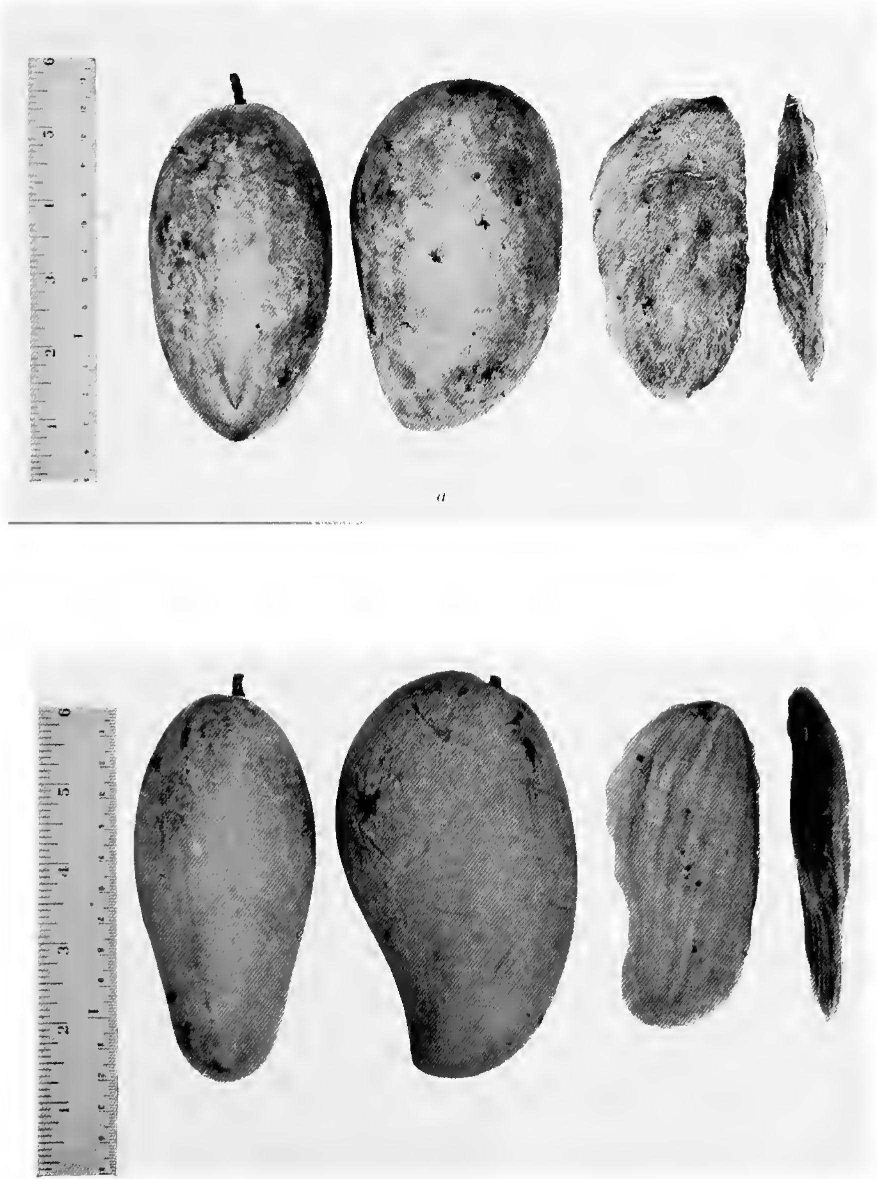
THE MANGO AS ILUSTRATED BY C. ACOSTA IN TRACTADO DE LAS DROGAS, 1578, p. 316



(*a*) "CARABAO" MANGO, FRUIT AND SEED; (*b*) "PICO" MANGO, FRUIT AND SEED.

from 15 to 40 centimeters long. The small racemes that make up the terminal panicle are in some instances subtended by small leaves. As many as 2,100 flowers are said to develop on one panicle.[48] Comparatively few flowers are perfect, the staminate strongly preponderating. The color, size, and odor of the flowers, the size of the panicle, and the proportion of perfect to staminate flowers, vary in the different races and varieties. The sepals are five, oblong, concave; the five lanceolate petals are inserted at the base of a tumid disk; the fertile stamens are one with four staminodia; the ovary is one-celled, the style filiform. The fruit is obliquely reniform, and exceedingly variable in form and size, from not larger than a small plum[49] up to a weight of over 2,710 grams,[50] and also differing widely as to the prevalence of fiber in the meat. The skin is green, yellowish, or red, in many shades according to the race or variety, and is usually dotted with numerous lenticels. The stigmatic area may be even or form a more or less prominent "nak,"[51] located near the beak or well along on the ventral side. The seed is reniform, and usually contains from one to six embryos, while as many as thirty are sometimes found in one seed.

THE MANGO IN THE PHILIPPINES.

INTRODUCTION.

The early navigators who discovered the Philippines do not refer to the mango. It is true that Pigafetta, who accompanied Magalhâes, mentions very few fruits from any of the countries he saw on the voyage during which he visited the Philippines, still his silence in regard to the mango can not be regarded otherwise than as significant, considering that he visited the Islands in March and April, probably leaving the first days of May, during which time the early mangos must have been in season, had the mango existed here. Still more so is the fact that it is not referred to by Antonio de Morga in "Islas Filipinas," a work published in 1609, republished with annotations by J. Rizal in 1890, while he mentions such fruits as the banana—of which he speaks of twelve varieties—the orange, citron, lemon, papaya, guava, custardapple, tamarind, jak, mabolo, santol, and pilinut. The probability that the mango was not yet introduced into the Philippines until after 1600 is strengthened by the fact that de Morga, who lived in the Archipelago for a number of years, speaks of "paos," a small, green fruit, like a nut, that is eaten as a pickle and has a good taste when well prepared. This is evidently the fruit of a native species of *Mangifera*, of which there are at least two. We can not but conclude from this, considering his description of the fruit, the absence of all reference to the quality of the fruit "paos" in its natural state and that he was not even familiar with the word mango, that the mango was in his time still unknown in the Philipines. Mercado, who was born in 1648, prepared a manuscript, probably between 1680 and 1690, on Philippine plants entitled, "Libro de Medicinas de Esta Tierra," that was published in 1880 in Blanco's "Flora Filipinas," Volume IV. A fruit called "paho" is here referred to as being preserved with salt, oil, vinegar, etc., but there is no description of the fruit to indicate the species; Mercado says that "they are called mangos by the Portuguese." This seems to be the first time the word mango is used in Philippine botanical literature and then only in an explanatory sense. It would seem certain that this fruit was one of the native species of *Mangifera* were it not for his remark relative to their "famous taste" on ripening, and if this fruit is the mango, the reference to it indicates that, a newly introduced fruit, it was still compared with the native wild paho and prepared in a similar manner. This theory would seem to be substantiated by the statement of Dr. Gemelli Careri, who visited the Philippines in 1697, who says: "There are also mangos from Siam—brought out of late years." Dampier,[52] who visited the Philippines in 1687, says: "The mangos here grow as big as apple trees—the fruit is as a small peach, but long and smaller toward the top. It is of a yellow color when ripe, very juicy, and of a pleasant smell and delicate taste." It is true that Dampier says that the mango grew wild in the larger islands, but not being a naturalist it is probable that he confused the mango with one of the native species of *Mangifera*, which in habit and foliage much resemble the mango. Delgado,[53] who finished this work in 1751, speaks of the introduction of the mango from Macao, but fails to mention a date even tentatively. G. J. Camello, who came to the Islands in 1688, prepared a manuscript on the plants of the Philippines that was printed as an appendix in Ray's "Historia Plantarum," Volume III, published in 1704. Camello, in this work, names six varieties of mangos, appending short descriptions thereof, none of which are known to-day and which were probably invented by him for the occasion. He speaks of several other fruits in the same connection, some of which are probably native species of *Mangifera.* No reference is made to the probable time of the introduction of the mango.

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[48] Curtis, Bot. Mag., Vol. VI, 3d ser., p. 4510.

[49] Bull. Bot. Dept. of Jamaica, 1901, Vol. VIII, p. 162.

[50] Jour. Roy. Hort. Soc., 1902, vol. 26, p. 763.

[51] "Nak" is the native Hindu word for the pistillate area of the fruit. Jour. Roy. Hort. Soc., 1901–2, vol. 26, p. 756.

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[52] Dampier, W. A., New Voyage Around the World, 1703, Pt. I, p. 391.

[53] Delgado, J. J., Historia de Filipinas, 1892, p. 502.

From the above data it may be concluded that the mango was introduced not later than about 1675 nor earlier than about 1600, and probably between the latter date and 1650.

At present, notwithstanding the great natural advantages to the fruit culturist, the mango industry in the Philippines can scarcely even be said to be in its infancy. The trees nearly always are planted on the edges of the rice fields and where other crops can not be cultivated. Notwithstanding this neglect, the mango thrives everywhere, as witness the many enormous trees 1.5 meters or more in diameter and exceeding 18 meters in height (see frontispiece), and from which in some years large crops of fruits are gathered. Still these trees produce only a small tithe of fruit compared to their normal bearing capacity. This is due partly to insect enemies which periodically appear in great swarms and destroy the bloom, and to some extent, the fruit; and it is probably partly caused by neglect, but by far the greatest reason for the sterility of the trees is believed to be the fact that all the trees are seedlings. A census taken in the summer of 1911 in a mango orchard in Muntinlupa, Rizal, showed that only 8 per cent of the trees bore a heavy crop of fruit, 15 per cent bore moderately, 28 per cent had a poor crop, and 49 per cent of the trees were unproductive. Only 23 per cent, or less than one-fourth of the trees, yielded a satisfactory return. It should be stated that these trees had suffered but little from insect attacks at the time of blooming. Judging from the observations made in other mango-producing districts, similar conditions prevail there. This tendency to sterility is not peculiar to the mango, but extends to many fruits. Some years ago a similar census was taken of seedling avocados in Florida and it was found that 3 per cent of the trees in the orchard produced 33 per cent of the fruit, 8 per cent of the trees yielded 66 per cent, 20 per cent of the trees produced more than 12 fruits each, and 43 per cent of the trees were sterile.[54] This fact is likewise well recognized in the fruits grown in the temperate zone, and for this, coupled with other reasons, these fruits are always propagated vegetatively, by budding, grafting, or as cuttings. The advantages derived from the budding and grafting of the mango are further discussed under the chapter on propagation.

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[54] Rolfs, P. H., The Avocado in Florida, 1904, p. 22.

SEEDLING TYPES.

Pomologically speaking, a variety may be defined as a group of plants propagated vegetatively from one original plant producing fruit of a distinctive appearance, texture, flavor, or aroma, by which characteristics it may be distinguished from fruit of other trees of the same species. Some of the botanical characters of the plants also may be distinct from those of other trees. In the temperate zone, where fruit growing has been well systematized and has become an established industry, this interpretation is well recognized.

Among the tropical fruits, the mango, unlike the banana and pineapple, has not been grown on extensive areas or for an exacting and discriminating market; and in the past there has been no very great demand for a sharp demarcation between its varieties as there is among deciduous fruits; and in consequence the seedling *types*, that heretofore have been generally grown and which reproduce themselves remarkably well from seed, have been called *varieties*. This is no less true of the mango in the Philippines than in other parts of the world where the mango is cultivated. These conditions are, however, rapidly changing wherever the mango is being subjected to systematic culture and the next few years should, here as elsewhere, witness great changes in the status of mango varieties as well as in its cultivation.

The Philippines were singularly fortunate in the introduction of the mango, in contrast to other parts of the Tropics where the species, as here, was introduced by seed, in that the fruits of the polyembryonic seedlings, which reproduce themselves true to seed, were of remarkably good quality (a feature of great value in a fruit that is not propagated vegetatively). There are three very distinct types of mangos in the Philippines: the Carabao, the Pico (also known as Padero) and the Pahutan, in some districts called Supsupen and Chupadero. The Carabao is the mango most esteemed and most generally planted. In the principal mango districts north of Manila, in Nueva Ecija, Pangasinan, Pampanga, and Bulacan, it is grown almost to the exclusion of all the other varieties and is largely planted in Cebu. The Pico is second in importance to the Carabao. It is mostly grown in the mango districts of Cebu and Cavite. The Pahutan seems also to be more grown in the provinces south of Manila than in the mango districts to the north of this city. The different mango districts in the Philippines apparently produce equally good fruit of a given type.

DESCRIPTION OF THE PHILIPPINE MANGOS.

CARABAO.

Average weight 230 grams; form oblong, asymmetrical, with full cheeks; ventral shoulder usually prominent; dorsal shoulder short; stem inserted square or oblique; base rounded; beak rather indistinct and variable, sometimes coinciding with apex; nak about 15 to 25 millimeters above apex, usually not prominent; surface smooth; color yellowish tinged with green; lenticels light yellow, usually sparse at basal end of fruit, abundant on apical portion; skin medium thin, tough; flesh yellowish, paler than the Pico, very tender and melting; flavor very delicate, aromatic and spicy; fiber medium coarse, short, confined almost entirely to edges of seed; seed oblong, medium large. Polyembryonic. The similarities in the fruit and trees of the Carabao and the Cambodiana, introduced into Florida from Saigon, Cochin China, are so many and great that the two types would seem to have a common parentage, or to have sprung one from the other; this fact perhaps may also indicate the original home of the Carabao mango.

The tree is of vigorous growth with fruit mostly ripening from the latter part of May through June and the early part of July; by smoking the trees (the physiological effect of which is not quite understood) and by chopping the bark of the trunk the Filipinos force the trees of this, as well as the following types, to bear fruit early in March, but this fruit is not so well flavored as that produced later. In some sections a few mangos are found in the markets during nearly all the months of the year.

PICO.

(Synonym: Padero.)

Average weight 215 grams; form oblong, semi-reniform, asymmetrical, flattened; stem inserted squarely or obliquely; base rounded; ventral shoulder usually prominent, sometimes compressed toward base; dorsal shoulder usually sloping; apex rounded; beak distinct; nak usually well above beak; ventral side above beak nearly always concave; surface smooth; color a light orange netted with brownish veins; lenticels pale yellow, sometimes almost entirely absent except at apical end; skin thick, tough; flesh a rich yellow, nearly always assuming a reddish tinge at apex; tender, but not melting like the Carabao, more rich and sweet than the fruit of that type, but having less than the Carabao of the spicy delicate aroma that distinguishes the Carabao, and which makes this perhaps the best flavored mango in the world; fiber fine and short, confined almost entirely to the edges of the seed; seed long, thin, medium large; embryo small, confined to basal end of seed. Polyembryonic.

The tree is of vigorous growth. Fruiting season May, June, and early in July.

Although uniform as types, there is considerable variation in the form and size of the fruit and presence of fiber and size of seed in both the Carabao and Pico mangos, and careful selection will not only bring to light varieties much larger than the average fruit of these types but also those having a much smaller percentage of fiber and seed than the average fruit.

PAHUTAN.

(Synonyms: Supsupen, Chupadero.)

Size small; weight averaging 75 to 100 grams; form oblong oval, asymmetrical; stem inserted obliquely; base roundish; dorsal shoulder usually sloping; ventral shoulder prominent; apex sloping toward beak; beak usually an obtuse point, not infrequently coincident with apex; nak slightly elevated, well above apex; surface smooth; color orange yellow tinged with green and finely netted with brownish veins; lenticels small, buff yellow, mostly toward apex; skin moderately thick, tough; flesh pale orange yellow, tender, very sweet, rich and aromatic; fiber medium coarse, profuse; seed large. Polyembryonic.

Season of maturity latter part of May, June, extending into the early part of July. Although the Pahutan is of excellent flavor this type cannot be considered to be of any value as a commercial fruit, for the reason that the fruit is too small and the seed too large with an excessive amount of fiber. It may have possibilities as a stock, however, as the trees of this type are exceedingly vigorous and trees are frequently found 1.5 meters in diameter with a crown 15 to 18 meters tall. (See frontispiece.)

It seems very probable that the Carabao, Pico, and Pahutan mangos were originally introduced as separate types into the Philippines and that from them have mutated the few scattered trees constituting the several minor forms of mangos such as the Pahut (a large form of the Pahutan), the Señora Cabayo, Cabuyo, Paho (distinct from the Paho in the Visayas), and Bulac. There are indeed two very distinct forms of the Señora, one that may be classed as a very superior Carabao in both appearance and flavor, and one very much smaller than the Carabao, with proportionately larger seed and more fiber, with a quite distinct flavor.

GRAFTED VARIETIES IN INDIA.

For many centuries choice varieties have been cultivated in India. The friar Jordanus writing of that country early in the fourteenth century says that "this is a fruit so sweet and delicious as it is impossible to utter in words," and a very large number of varieties are now grown there.

Woodrow describes the following varieties of mangos cultivated in India:[55] Afonza, Alphonse, Amiri, Badshaha, Banchore, 2 varieties; Banka, Bada-Mawa, Batasi, Bhopali, Bhunga, Bishop, Bolo, Borsha, Codria, Colleca, Costa, Cowasji-Patel, Custodio, Dalbed, Deorukhia, Diniz, Dilpassand, D'Joao, Dulce, Durma, Fernandez, Fernandino, 2 varieties; Frederico, Furtado, 2 varieties; Fusli-Bewa, Gadgya, Goa, Goradya, Gopalbogh, Inerna, Jamshedi, Jeepria, Kabutria, Kale-Alphonse, Kavasji-Patel, Khoont, Kubdia, Kalia, Kaelia, Kagdi-Alphonse, Khatkia, Kumukht, Langra, Lerrua, Mahalunga, Mahaluga, Malda, Mulgoba, Moria, Mussarata, Naralya, Narayan, Newsharwani, Nowshari, Ogee, Pakria, Pandria, Piru, Pia-Posha, Pyrie, Ragu, Rajia, Ryotya, St. Aime, Salgada, Salgadina, Shirka, Shah-Pasand, Shendria, Swrawini-Alphonse, Sucretino, Surkhya, Timor, Totapari.

C. Maries,[56] an Indian mango expert, collected no less than "500 varieties." He groups the mangos together in the following five sections:

Section I: No general designation or name is given to section I, in which all the early varieties are included.

Section II: Kerbuza mangos, which name has been derived from the musk scent which these varieties possess.

Section III: Budaya. This class of mangos, also called Malda, has peculiarly shaped fruits that seldom mature before the middle of July, and which with care and protection keep until late in October. The mangos in this group are nearly all large, ranging from 450 to 900 grams in weight.

Section IV: Barramassia (meaning twelve months) includes several varieties that are everbearing, or that fruit throughout the year. Unfortunately, these varieties are not of good quality.

Section V: Luttea, the creeping mangos, of which several grafted forms exist, grown more perhaps as curiosities than for their economic value.

The Alfonso, perhaps more celebrated than any other of the older varieties, has already been successfully introduced into the United States. Of those that have recently come into prominence and are as yet comparatively unknown varieties, may be mentioned the Ennurriva (meaning "spontaneous") and the White Alfonso. A line-drawing of the Ennurriva was figured with that of several other varieties in the Journal of the Royal Horticultural Society, 1901–2, volume 26, page 763. This is said to be of fine, delicate flavor and weighs from 900 to 2,700 grams.

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[55] Woodrow, G. M., The Mango, 1904, pp. 25–32.

[56] Watt, G., Dic. of Ec. Prod. of India, 1891, Vol. V, pp. 149–152.

DESCRIPTIONS OF FIBERLESS INDIAN VARIETIES.

Ameeri.—Size large; weight 500 to 565 grams; length 15 centimeters; form oblong oval, flattened, compressed at base; apex rounded, the curve ending in a distinct beak at nak; nak 2 to 2.5 centimeters above apex; surface moderately smooth, undulate; color greenish yellow with garnet red on sun-exposed side extending toward base; lenticels conspicuous, whitish or grayish; bloom whitish; skin medium thick, tough; seed comparatively small to medium; fiber short, confined mostly to edges of seed; flesh pale yellow in color, moderately tender, juicy, flavor sprightly acid; quality very good; should make a very good cooking mango. Season, latter part of June and July.

Bennett (synonym: Douglass Bennett's Alphonse).—Average weight 225 to 350 grams; form irregularly roundish with stigmatic point well up on the ventral surface; surface smooth; color yellow, shaded with pink on sun-exposed side; lenticels rather conspicuous; skin moderately thick; seed medium to large; fiber scant and fine but rather abundant for a "fiberless" variety; flesh yellow, very tender and melting, less aromatic than the Mulgoba, but of very good flavor with a sprightly acidity near the seed. Monoembryonic. Season of maturity, July. The tree is of vigorous growth and a prolific bearer.

Cambodiana.—Size medium to large; shape oblong, oval, asymmetrical, with prominent, medium high nak, surface moderately smooth; color greenish yellow to saffron yellow; lenticels numerous, russeted; skin thin; seed medium; fiber very short, confined largely to ventral edge of seed; flesh yellowish, quality very good, the meat possessing a very delicious spiciness, sweet and rather mild, melting and juicy, partaking of the flavor of the Carabao type. Polyembryonic. Season, latter half of June and early part of July. The leaves are very large with prominent veins. The variety appears to be of vigorous growth, and precocious.

Gordon (synonym: General Gordon).—Average weight 260 to 370 grams; form irregularly elliptical ovate, with prominent nak 2 to 2.5 centimeters above apex; surface smooth; color chrome yellow suffused with green, tinged with orange vermillion on sun-exposed side; lenticels brownish; skin medium thick; seed medium to rather large; fiber medium; color of flesh yellow; flavor richer than the Totafari but not so delicate; quality good to very good. Monoembryonic. Matures during June and the early part of July. The variety is moderately vigorous and fairly prolific.

Langra Benarsi.—Very large, average weight 900 to 1,300 grams; form elliptical ovate, oblique, flattened; nak prominent, about 3 centimeters above apex; surface undulate; color dark green marbled with light green; lenticels small, russetted; bloom whitish; skin medium thick, tough; seed comparatively small; fiber medium; flesh yellow, tender, juicy and very acid; quality good; not a dessert fruit, but may make a good fruit for preserving. Season, August.

Mulgoa.—Size medium to large; form roundish, oblique, shoulders even; apex rounded; nak about 3 centimeters above apex; surface rather rough; color green marbled with yellow; lenticels numerous, russetted; skin thin, tough; seed small; fiber short, mainly on ventral edge of seed; flesh pale yellow, tender and juicy; flavor sprightly acid, aromatic with a trace of turpentine; quality good to very good. Season, August. The tree is vigorous and of good habit.

Mulgoba.—Average weight 350 to 425 grams, occasional fruits weighing 575 grams; form roundish oblique, reniform; nak usually prominent, well up on the ventral surface; surface smooth; color yellow beautifully blushed with red; lenticels numerous; skin thick, tough; seed medium; fiber very scant, short and coarse; flesh rich apricot yellow, tender and melting; aroma rich and pleasant; quality exceedingly good. Monoembryonic. Season, latter part of July and early half of August. The tree is very vigorous and of symmetrical growth but rather lacking in precocity. This variety has not proved to be a constant and prolific bearer; from the observations of the writer this is to a large measure due to imperfect fertilization of the flowers. The defect might be overcome by the discovery of some variety whose pollen is more potent than its own, trees of which might then be planted among the Mulgoba trees.

Paheri.—Size medium to large; weight 270 grams; form roundish, oblique, flattened; nak prominent, about 2.5 centimeters above apex; surface moderately smooth; color golden yellow marbled with green, garnet red on sun-exposed side toward base; lenticels small, russet or yellow; bloom bluish white; skin thick and tough; seed small; fiber almost entirely absent; flesh rich yellow, very tender, melting and juicy; flavor sweet, rich and aromatic; quality excellent, superior to all the mangos described in this chapter. The Paheri is a vigorous grower and of good habit. Season, July.

Père Louis.—Size small; form roundish oblong, reniform, swollen at nak; nak 2.5 centimeters above apex; surface greenish yellow to deep yellow, with a suggestion of red; lenticels small, numerous, brownish; bloom bluish white; skin medium thick; seed large; fiber rather abundant, fine; flesh yellow, tender and juicy; flavor sweet and rich; quality good; moderately vigorous. Monoembryonic. Season, July.

Peters (synonym: Peters No. 1).—Average weight 250 to 280 grams; form almost spherical, asymmetrical, with prominent nak, about 20 to 25 millimeters above apex; surface moderately smooth; color oil green to olive yellow, turning to cadmium yellow and orange chrome on sun-exposed side; lenticels numerous; bloom bluish white; skin thick and tough; seed small; fiber almost entirely absent, confined to ventral side of seed; flesh orange yellow, tender and melting; flavor exceedingly rich and sweet, but lacking in sprightliness; aroma distinct. Monoembryonic. Season, late in July and early part of August. The variety appears to be a vigorous grower, prolific, and of good habit.

Sandersha (synonyms: Sundersha, Soondershaw).—Size very large, average weight of fruit 575 grams, occasionally attaining a weight of over 800 grams; form oblong oval, flattened, compressed and tapering toward base; apex rounded, terminating in a distinct beak at nak; nak distinct, about 2.5 centimeters above apex; surface smooth; color clear yellow with a pinkish blush on sun-exposed side; lenticels small, numerous, russetted; skin moderately thick; seed long, comparatively small; fiber almost absent; flesh rich, reddish yellow, juicy and tender; flavor mild, sweet and aromatic, but inclined to be acid near the seed. Monoembryonic. Season very late, the fruit ripening late in August and the early part of September. The Sandersha is of moderately vigorous growth, prolific, and of good habit.

The above descriptions of mango varieties in India should prove of particular interest to anyone contemplating the introduction of varieties from that country into the Philippines.

Considering the superior quality of the mango in the Philippines, one might argue that time, money, and labor devoted to the introduction of other kinds from abroad is ill spent, but nothing can be more erroneous. In its season after due selection among our own types it is beyond question that we have here one of the best flavored mangos in existence, but its season is comparatively short, the exterior of the fruit is lacking in attractiveness, and the seed is proportionately larger than in some of the varieties cultivated in India. By the introduction of several of the varieties grown there, the mango season can be prolonged until late in October, larger and more brightly colored fruits can be obtained for a fancy market, some of which would be especially adapted for canning and other preserves. It should not be forgotten that by the crossing of these varieties with the Carabao and Pico, new and very valuable varieties may be originated.

THE MANGO AS AN ORNAMENTAL TREE.

Aside from its value as an economic plant, the mango when full grown is one of the most majestic and ornamental trees in the Tropics, and for this reason it may be utilized to advantage in laying out a park or garden. It is singularly effective as a solitaire on the lawn, and is also suitable as an avenue tree. When used for the latter purpose it should be kept in mind that the various types differ in habit, and for the best effect all the trees should therefore be seedlings of the same type, preferably those with tall trunks and upright habit.

PROPAGATION.

THE REARING OF STOCKPLANTS.

The foundation of thrifty, productive trees is healthy, vigorous stockplants. For this reason the seed should be carefully selected from healthy, vigorous trees and all small and poorly developed seed and seed from windfalls and immature fruit should be rejected. Horticulturists throughout the world are beginning to realize more and more the profound influence exercised by the stock upon the scion and many interesting and valuable facts have been noted in many instances where this feature has been studied. No experimental work along these lines has ever been undertaken with the mango and nothing is in consequence known of the influence of a certain type of stock upon the budded part of the tree. The author has started a stock test of the leading mango types in the Philippines and it is hoped that all growers who undertake to topwork their old seedlings will keep careful records of to what type the original trees belonged and communicate the results to the author. It is quite probable that some of the types will prove far more desirable as stock than others.

The mango seed loses its germinating power within a comparatively short time unless it is kept moist, and should, therefore, be planted as early as possible. The methods of propagation of the stockplants will differ according to the methods employed in converting them into grafted plants. If the plants are to be used as stocks in inarching, the seed may be planted in pots or boxes. If it is planned to use the method of inarching, by planting the seed near the edge of the box or pot, it will be easier to make the inarch without much bending or forcing of the stock into the proper position than if the plant is grown in the center of the pot. The seed should be laid flat on the ground and covered thinly with soil. After the seed is planted the pots should be placed in a frame in a slat-house with about half shade, and covered with seaweed or half-decayed leaves or straw to prevent the rains from beating out the soil. This will also keep the soil moist and render less watering necessary. Care should be taken to keep the soil not too wet for in that case a large percentage of the seeds will decay without germinating, and those that grow will be weak and sickly and frequently subject to the damping-off (*Sclerotium* sp.) and the mildew (*Oidium* sp.); two fungus diseases the presence of which indicates untoward conditions.

The damping-off fungus attacks the plant just above or a few centimeters from the ground when it is young, tender, and brittle, before the tissues have hardened; part of the stem becomes soft as if scalded, and the plant falls over.

The mildew is recognized by the appearance of the underside of the leaf, which becomes covered by the flour-like sporangia, giving the leaf the appearance of having been sprinkled with fine, white dust. The leaves subsequently curl up and become distorted.

Both these diseases are warded off by keeping the plants rather dry. If the plants are attacked by the damping-off, take out all diseased plants and dust the rest liberally with flour of sulphur; withhold water to the point of wilting. The mildew is controlled by the same measures.

Sometimes the young plants are attacked by the mango blight fungus, whose presence is indicated by the spotted and disfigured leaves. Applications of Bordeaux mixture usually correct this trouble if the conditions for the plants are otherwise congenial.

The soil most suitable for mangos in potting or in the propagating bed or frame is a sandy loam rich in humus. If pots are not available when the seed is ready for planting, the seed may be planted in a bed or frame, that has been prepared by grubbing the soil thoroughly to a depth of 30 centimeters, removing carefully all stones and trash, and adding some well-rotted cow manure or some commercial fertilizer well pulverized and thoroughly mixed with the soil; the seed should be planted in rows about 10 centimeters apart and 10 centimeters apart in the rows, and about 1 to 1.5 centimeters deep. When the first growth of the plant has matured—i. e., when the leaves are dark green and leathery—they are ready to be shifted to boxes or pots. The roots of the mango are very fine and brittle, and great care should be taken to protect the young roots from drying out; and if transplanting is done on a bright day, the plants should preferably be shaded for a few days after planting. As soon as the plants are potted off, they should be given a thorough watering, but should subsequently be kept dry to the point of wilting, until they are well established. Young mangos do not like excessive moisture, and when kept in pots—which should always be provided with ample drainage—under more or less artificial conditions, it is well not to keep the soil continually wet and soggy.

Plants in pots or boxes soon exhaust the supply of plant food, and it is therefore necessary to renew the fertility by artificial means. Where cow manure is available, this should be strained through a sieve or coarse cloth with water into a barrel and diluted until it is of the color of weak coffee, and the plants be watered with the manure water once in two or three weeks as the appearance of the plants may indicate. Frequently manure cannot be obtained, however, and resort must be had to artificial fertilizer. Where this is necessary, only the most soluble chemicals should be used, in order to get an even solution and a quick-acting fertilizer. The writer has for several years used the following formula for all kinds of tropical plants (applied as directed for the manure water), with excellent results:

Nitrate of soda	grams	275
High grade sulphate of potash, 50 per cent	do	125
High grade acid phosphate, 16 per cent	do	350
Water	liters	100

Care should be taken to see that all the constituents are well dissolved. The acid phosphate has a tendency to settle, and the solution should, therefore, be stirred up now and then as the watering proceeds.

If the plants are to be budded in the nursery, the seed may be planted in a bed (as already described) and as the plants attain the proper size they are set out in the nursery at the operator's convenience. A dark, cloudy day should be selected for this work, and the greater part of the foliage should be removed; the taproot at the same time should be cut back considerably to induce the development of lateral roots so as to facilitate the final transplanting of the trees from the nursery to their permanent position in the field, or in the removal of the budded trees to boxes to become established before they are sold or planted out. The seeds may also be planted in rows in the nursery, and should then be planted about 15 to 20 centimeters apart, in rows 120 centimeters apart, or more, to admit of machine cultivation. The land selected for the nursery should preferably be a sandy or clayey loam, rich in humus, well drained, grubbed to a depth of 30 centimeters, and well cleared from stones and trash. After the seed is planted, the rows may be mulched to advantage with a thin layer of half-decayed leaves, grass or straw, to keep the sun from drying out the soil around the seeds. If the seed is planted direct in the nursery, it is well, when the plants are about 30 centimeters high, to insert a sharp spade obliquely into the ground so as to strike and cut off the taproot about 15 to 20 centimeters below the surface of the soil, in order to induce the plants to form a better lateral root system. Seedlings may also be reared in bamboo tubes and planted in the orchard when 20 to 30 centimeters tall with the expectation of budding them later.

INARCHING.

When the plants have attained the diameter of a lead pencil they are ready for inarching. On account of the heavy winds that are more or less a frequent occurrence in the Tropics, the trees from which the inarches are to be taken should preferably have a stout fence built around them, made of strips 2.5 by 7.5 centimeters or bamboo, with openings 5 centimeters wide between the strips to break the force of the wind. If the tree is not too large this skeleton fence may be roofed with the same material or with lath, admitting half light. This will also tend to obviate the necessity of watering the pots or boxes containing the stock so frequently while the union is being formed, and to prevent the burning of the roots in the pots by exposure to the sun.

Before the inarches are put on it is necessary to erect a stout scaffolding around the tree, of a size according to the number of inarches to be made. If the tree is in the open, particular care should be taken to have the scaffolding well braced, to prevent its being swayed by the wind, and the inarched branches firmly tied to the scaffolding.

Inarching is the most primitive way of propagating the mango and probably with the exception of cuttage, the earliest vegetative method employed in the propagation of plants. The work is performed by removing the bark of the seedling with one cut by a sharp knife so as to expose the cambium layer for about 7 centimeters as near the roots of the stock as practicable; perform the same operation about 7.5 to 10 centimeters from the terminal bud of a twig on the tree from which the inarch is to be taken, selecting a twig of as nearly as possible the same diameter as the stock, so that when the two cut surfaces are pressed together they will make a snug fit. The stock and the scion should be firmly tied together, but not tight enough to strangle, with preferably grafting tape,[57] covering up the whole length of the cut. Lacking grafting tape, soft cotton twine saturated with grafting wax will answer. Untreated twine is undesirable as it shrinks from the effect of dew or rain, constricting and strangling the young plant and preventing the free flow of sap. The pot should be firmly affixed to the staging to prevent any dislocation of the cut surfaces by heavy winds, and if the tree from which the inarches are made grows in the open, a piece of sacking or burlap should be tied around and over the pot to keep the roots from drying up from exposure of the pots to the sun and wind until the union has been made, which in the summer when the growth is more rapid will be from four to six weeks, while late in the fall it will take longer. Watering

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[57] A wax preferred by the writer in grafting, or for making wax-cloth is made of equal weights of beeswax and resin. Other receipts that are recommended by writers on this subject are:

Resin	kilograms....	3
Beeswax	do........	1
Linseed oil	liter....	0.5

or

Resin	kilograms....	2
Beeswax	do........	1
Tallow	do........	0.5

The wax is prepared by placing the ingredients in a suitable iron pot and melting them over a slow fire. Liquid wax may be made by melting 1 kilogram of wax and adding 0.75 liter of alcohol; mix thoroughly and keep in a tightly corked bottle.

The best material for grafting tape is cheap cotton cloth that tears easily. Rip up the cloth into strips 15 to 20 centimeters wide. Wind the strips of cloth on stout iron wire until the roll is not more than 5 centimeters in diameter; if thicker, the wax will not penetrate to the center. To prevent the cloth from being undone, tie a string around the end of the roll. The weight of the wire will cause the rolls to sink in the mixture while the cloth absorbs the wax; if sticks of wood are used on which to wind the cloth, the rolls should be weighted down. Place the rolls in the melted wax, which will saturate the cloth in about 15 minutes. Do not let the mixture come to a boil, or the cloth may be burned. When ready to use, unroll the cloth and tear it into strips about 2 centimeters wide.

should be carefully and regularly attended to for if this is neglected more time is required before the union is effected; and furthermore, such neglect weakens the plant, so that it can not so rapidly establish itself after it is planted out.

About three weeks after the inarch is made a notch should be made in the stock just above the union, and another immediately below in the scion; after a week the lower notch should be made a little deeper and the top removed; in another week the lower notch should be made still deeper; and six weeks after the inarch was put on the plant can usually be completely severed from the tree. If an inarch can be made from a young shoot that is just ripening up, before the wood has become hard and rigid, the union is effected in much shorter time.

Should the union, for some reason, take place very slowly, the inarched twig may throw out one or two flushes, or growths, before it is detached, in which case it will be well to cut off the greater part of the foliage when the inarch is severed, in order to prevent excessive evaporation, which would result in the drying up of the scion before good circulation of sap is established. The cut surfaces should be made smooth with a sharp knife, and the cuts painted with white lead, or covered with grafting wax to prevent the entrance of fungi. The plants should now be kept in a plant shed and carefully attended to for a few weeks, and allowed to make at least two or three good growths before they are planted out in the orchard. This extra trouble will be well repaid by the rapidity with which the plant establishes itself after planting.

Bernays [58] thus describes a method of propagating the mango then being tried in India: "The seedling, with seed attached thereto, when it is about 15 to 20 centimeters high and three weeks old, is carefully lifted with a small ball of earth. The roots, with the earth intact, are then wrapped up in a little grass, and the young seedling plants tied to the tender branch of the tree required to be inarched from, care being taken that the young seedling trees and the branch to be grafted should be pointed in the same direction, and to be of the same age; i. e., both seedling and graft should be of that year's growth. When grafted the union should be covered with grafting clay to exclude the air. The roots of the seedlings, suspended as above described, when grafted, must be kept moist by watering, either by hand or with a garden syringe, in case there is not sufficient rain.

The process of grafting should be commenced in the beginning

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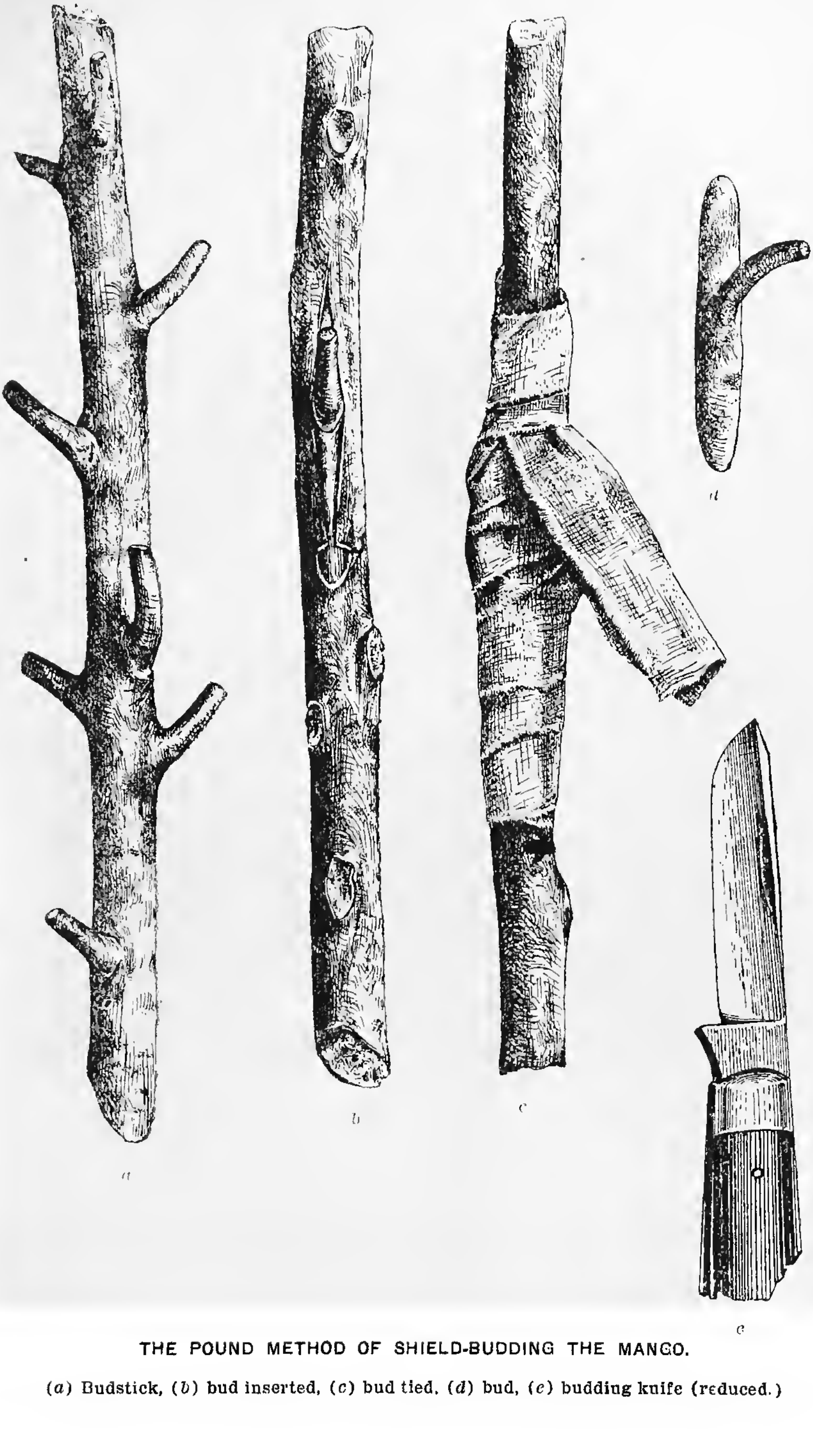
[58] Bernays, L. A., Cultural Industries for Queensland, 1883, p. 125.

PLATE IV.



THE POUND METHOD OF SHIELD-BUDDING THE MANGO.

(*a*) Budstick, (*b*) bud inserted, (*c*) bud tied, (*d*) bud, (*e*) budding knife (reduced.)

OLD MANGO PRUNED PREPARATORY TO TOPWORKING.

of the rainy season, as soon as the young mango seedlings are procurable. The plants should be ready for cutting, i. e. the graft should have taken well within a month; the graft should be partly severed at first, and completely severed afterwards, but I have succeeded in cutting them as soon as thirteen days after grafting."

In countries where the humidity is great and the rainfall abundant during the last four months of the year in the Northern Hemisphere and the corresponding months in the Southern, the above method which has, with certain modifications, been used successfully by G. W. Oliver in the propagation of mangos in the greenhouses of the United States Department of Agriculture, Washington, D. C., may prove practicable in the hands of an experienced propagator and under favorable circumstances, but is unlikely to come into general use. It should be used only during the seasons of the year when storms or high winds are less likely to occur, and the stockplants should be reared in small pots rather than be raised in the open ground and lifted. Sphagnum moss is preferable to grass for wrapping around the roots.

In the experience of the author wooden boxes, made of boards 12.5 centimeters wide, sawed off so as to make a box 30 centimeters deep, a piece 12.5 centimeters square and 1.5 centimeters thick, in which a hole has been bored with an auger of 2.5 centimeters diameter for drainage, supplying the bottom, have been found more satisfactory receptacles for mango plants than the ordinary flower pots usually employed. The plants having more soil in which to grow, develop more rapidly, make stronger plants which do not become pot-bound, and establish themselves more quickly in the orchard than when the stock has been grown in pots. The size and weight of these boxes, however, are great disadvantages where the plants are to be shipped long distances.

GRAFTING.

In India, crown grafting seems to have been practiced quite successfully, and Woodrow[59] devotes considerable space to the description of this method. However, it appears to be rather impracticable and cumbersome, requiring considerable attention and time.

A modification of grafting and inarching was employed successfully in working over seedling trees, by the Rev. E. Gale, West Palm Beach, Florida, who took a scion 30 to 45 centimeters long, and exposed the cambium layer of the scion and stock (as already described under inarching) and, after tying it firmly to the stock, heaped soil around the point of juncture, covering up three-fourths of the scion to keep it from drying out until the union had been made and a good circulation of sap between the stock and scion established. This method may be employed, however, only in converting small seedling trees in the field to trees bearing superior fruit, and when grafting material is abundant. It would not recommend itself in a nursery. It is interesting to note that this method was employed in the propagation of the mango over seventy years ago. In this instance a long twig was grafted onto the young stock in pots in the same manner as described above, and the basal end stuck in a bottle filled with moist sand.[60]

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[59] Woodrow, G. M., Gardening in India. 1899.

Wedge, or side grafting has also been used in Florida with some success. This operation is performed by making a long slanting cut in the stock about 5 to 8 centimeters above the ground, for the insertion of a wedge-shaped scion. A small cylinder of tar paper is subsequently placed around the grafted plant and wet sphagnum moss placed around the junction, which is kept moist until the graft has "taken," when the top of the stock is cut off.

BUDDING.

About eight or ten years ago attention was first directed to the methods of propagating the mango by means of buds. In Queensland the patch method was first successfully employed by H. Knight.[61] Later it was successfully applied in the United States by George B. Cellon, Buena Vista, Florida,[62] and G. W. Oliver, United States Department of Agriculture, Washington, D. C.[63]

Patch budding consists in the removal of a square or triangular piece of bark from one tree and fitting in its place another piece of bark of the same shape and dimensions, so as to make a tight fit, after which the bud is tied carefully with grafting tape to exclude all moisture and keep the bud from drying up before union has taken place. A prime requisite when the patch bud is employed is that the sap must be flowing freely, in both the stock and the branch from which the buds are taken, in order that the bark may be removed easily and without injury. The stock must of necessity be older when this method is employed than when the shield bud is used, and the method is necessarily more cumbersome.

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[60] Trans. Agr. Soc. India, 1838, Vol. II, p. 260.

[61] Queensland Agricultural Journal, 1900.

[62] Trans. Fla. State Hort. Soc., 1902, p. 15.

[63] Bureau of Plant Industry, Bulletin 46, 1903.

Shield budding has been practiced with partial success in Florida for the last six years and was first experimented with by the author in 1904. The percentage of successful buds was, however, so low that he did not then feel justified in calling this method to the attention of the public. During the last four years experimental work along this line has been continued by a few men interested in the problem, and this work has, in some instances, met with remarkable success. The success achieved by Orange Pound, Cocoanut Grove, Florida, deserves special mention, since his operations have been more extensive and his success more signal than those of anyone else. Mr. Pound's experience includes the budding of young plants in the nursery, and topworking old trees. In 1909 Mr. Pound had so perfected his method that on a visit to his nursery the author found that among a lot of 300 budded plants, 85 per cent had developed to healthy trees. The description of this method has been prepared with the aid of data furnished by Mr. Pound, and it was first published and illustrated in the Rural New Yorker, September 10, 1910.

Success depends on having the stock plant in prime condition, the sap flowing freely; the buds should be selected from well-matured wood that is still green, of the first, second, and third flushes from the terminal bud, and cut rather large—3 to 5 centimeters long. The lower, thick, swelled part of the petiole at the base should be allowed to remain on the bud until it sheds voluntarily. If the petiole is cut too near the bud, fungi frequently gain entrance through the wound and destroy the bud.[64] It appears to be equally satisfactory to push the buds up or downward.

To facilitate the insertion of the bud, it is well to trim off the edge of the horizontal cut, as illustrated in Plate IV. In tying the bud, allow the remnant of the petiole to stick out between the strands of the tape, and protect it and the bud from the dew and rain with a square piece of waxcloth held in place by one of the strands of the tape above the bud. It is essential that the buds should be inserted at a point in the stock where the bark is of about the same age as the budwood—i. e., green and smooth—and the work done when the plant is in flush. When the union has been effected, which will be in the course of two or three weeks, the stock should be pruned off about 15 centimeters above the bud. The buds are sometimes very dilatory about starting, and in order to force them out the plants should, after the buds have taken, frequently be gone over and all adventive buds rubbed off.

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[64] It is possible that the leaves could to advantage be trimmed off the budwood while it still remains on the tree, and the budwood used after the petioles have dropped and the leaf scars are well healed. This was done successfully in budding black walnuts by the late W. N. Irwin in the late eighties.

Another method, called by him "slice-budding," has been employed with considerable success by Mr. Pound. In using this method the budwood should be sufficiently old to have turned brownish and rough and the stock, at the point of insertion of the bud, be of the same character.

In using either of the methods of budding described above, the stock should at the time of budding be girdled 15 to 20 centimeters above the bud.

Mr. J. E. Higgins, horticulturist of the Hawaii agricultural experiment station, Honolulu, Hawaii, describes a method of shield-budding the mango which has recently been tried with success there.[65]

An unusually large shield, 7.5 to 9 centimeters long, is recommended by him, and that the buds should be inserted on well-matured stock where the bark is rough and brownish, using budwood of the same character.

The various methods of propagation here described may be used to fit individual conditions, but under ordinary circumstances the Pound method of shield-budding the mango will be found the most practicable in the open ground.

In all propagation work it is very important that the budding or grafting knife should have a keen, sharp edge. A good test is to try the knife on the wrist or forearm; if the knife does not shave the hair readily it should be sharpened or honed.

So far as the writer is aware the method employed in propagating *Ficus elastica*, crotons, and many other plants under glass by means of girdling a branch and tying moist sphagnum moss around it at the point of girdling, has not been tried with the mango. This method, called marcottage, may be worth investigating.

The grafting of the mango on the cashew (*Anacardium occidentale* L.) and which is reported to have been accomplished in Martinique, is said to dwarf it;[66] the fruit, moreover, grown on this stock is reported to double its size and to become free from fiber, with the seed so reduced as to frequently lose its germinating power.

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[65] Higgins, J. E., Shield-budding the Mango, Hawaii Agri. Exp. Sta., Bull. No. 20, 1909.

[66] Jumelle, H., Cultures coloniales, 1901, p. 212.

TOPWORKING OLD TREES.

On another page the sterility of the seedling trees in the Philippines has already been pointed out. How to remedy this evil is to-day the most pressing problem confronting the mango grower. In so far as the inherent productivity or sterility of the trees are concerned, this may be controlled by grafting or budding the top of the large seedlings into varieties that are known to bear well; nor is this the only advantage derived from budding—the fruit produced will be uniform, and by careful selection from one's best seedling trees, a larger fruit with less than the average amount of fiber and a smaller seed may be grown; and the season of maturity of the mango materially lengthened by budding to early and late ripening varieties. Nor is this all, for the budding process has a tendency to dwarf the trees and thus the fruit may be gathered with greater facility than from the tall seedlings, and noxious insects are combatted more easily. Of course, the budding of small trees is accompanied by the same advantages.

In topworking old trees it is first necessary to provide for suitable "stock," so to say, in which to insert the buds. This is accomplished by pruning back the main branches about 30 to 60 centimeters from the trunks; in doing so, prune off those branches which are to carry the new top, leaving the weak and poorer ones to maintain the circulation of sap and to shade the trunk and branches until a new top has formed. In the course of a few months a number of sprouts will issue from the pruned branches and as soon as these are large enough, the most desirable ones should be budded and treated as already described under budding plants in the nursery. All unbudded sprouts should be pruned off smoothly. All wounds should always be well painted with white lead and linseed oil; if this is not available, coal tar may be used as second choice, or clay and dung mixed. In cutting off large branches it is always well to have the cut sloped a little so that rain and dew will not remain long on the exposed surface. Never apply so much paint or coal tar that it runs down the limb.

As the buds increase in size, remove the original top gradually; care should be taken, however, not to prune too severely which may injure the tree permanently, or even kill it.

SHIPMENT OF MATERIAL FOR PROPAGATION.

Seeds that are to be shipped long distances should be thoroughly washed free from the pulp and spread out on the floor to dry in the shade for one to three days. Pack the seed in coconut fiber, sphagnum moss, or sawdust from hardwood trees, free from resin, that contains just enough water to make it feel moist when it is taken in the hand and squeezed. The different kinds of packing material are preferable in the order named. In packing employ sufficient packing material so as to keep each seed separate. Packed in coconut fiber or sphagnum moss, the seeds may be shipped in bulk, but the sawdust, even in small boxes, has a tendency to heat and the seeds are consequently destroyed. Small lots of seeds may be packed in either of the substances mentioned above, in cigar boxes lined with waxed paper in order to prevent the escape of any moisture in transit, and mailed. Seeds thus shipped by the writer from the Philippines to Florida have arrived with a loss of only 20 per cent.

In the shipment of scions or budwood these should be selected from straight growths of *well-matured* wood somewhat larger in diameter than a lead pencil and from which all leaves have dropped and all leaf scars are well healed. Wrap the scions in either of the packing substances recommended for packing the seed and containing the same amount of moisture, in stout oiled or paraffin paper, around which wrap corrugated paper sufficient to protect the scions from all injury in handling in the course of transit; as a final covering use a good grade of Manila paper. If tin tubes are available the scions may be packed in these without using oiled paper.

CULTIVATION.

SOILS.

The mango seems adaptable to a wider range of soils than most fruit trees: "The best fruits and finest trees in the plains are always produced on trees grown on raised ground . . . . In Bengal it grows equally well in a deep river deposit, in clayey, or in sandy soil."[67] This statement is corroborated by all evidence in the Philippines, where, excepting in extremely stony and shallow soils, the mango thrives in all classes of soils reasonably well drained where it is planted. The mango seems to require considerable space for the development of its root system in order to do well, and trees planted on land where the soil is shallow never attain large size and are not long-lived. The mango is less susceptible to injury by an occasional temporary rise in the water table, submerging the root system, than many other tropical fruit trees, notably the avocado, and it therefore flourishes where the avocado, for this reason, would fail. The most desirable sites for an orchard will be found on well-drained land, with poor but fairly deep soil.

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[67] Watt, G., Dictionary Ec. Products of India, 1891, Vol. V, p. 148.

A yearly rainfall of 1,250 to 2,500 millimeters, falling mainly from June to the end of September, is most suitable for the mango, but where irrigation is available it will succeed with less rain than this.

CLEARING.

In setting out a mango orchard, the land should preferably be cleared a year previous to the time when it is planned to set out the trees. If the land is covered with timber, the stump should be removed with a stumppuller, or dynamited and burned, and the land planted with a leguminous cover crop. The roots of this will open up the soil, add humus and nitrogen, and altogether put the land in good condition before the plants are ready to be set out.

An orchard may also be started by clearing away the timber and largest growth from the ground, after which the land is staked and a circular area cleared around each stake where a tree is to be planted. As the trees increase in size, the circle in which they stand should be enlarged until ultimately the land is entirely cleared.

PLANTING.

It is well to dig the holes for the trees a few weeks in advance of the time of planting. Make the holes about 60 to 80 centimeters wide and 40 to 50 centimeters deep. In planting the trees fill the holes with surface soil instead of the acid subsoil dug out of the holes and work in the soil carefully among the roots allowing them to remain in as natural position as possible. The mango should never be planted deeper than it stood in the nursery; it appears to be as susceptible in this regard as are the citrus trees.

On being set out the plants should be well watered. Pot-grown plants should be closely watched and watered frequently until they are well established. They are in this respect more particular than trees grown in a nursery, having all the roots matted together in a small ball of earth and not coming in contact with so much moisture as they would if the roots were spread out in the soil. Where the trees are planted out from large wooden boxes they establish themselves more rapidly, but, nevertheless, require somewhat more attention with watering than nursery-grown trees. To prevent excessive evaporation until the trees have become established, it is well to prune away about two-thirds of the foliage and all tender growth; it is also of benefit to cut some leafy branches and stick them in the ground around the young plant for shade. Mulch the plants heavily.

An orchard may also be established by planting seeds "at stake" where the trees are to remain, with a view to budding the young plants or topworking them after they have become of some size. Already in possession of a well-established root-system, trees worked over in this way rapidly develop a good top. This method has much to recommend it considering that the mango is at present thought to be transplanted with difficulty, particularly for those not well versed in the transplantation of trees and plants. If this method is adhered to it is well to plant three to four seeds together in each "hill" to insure a good stand; as the seeds germinate all but the best plants are thinned out in each hill.

There is a great diversity of opinion as to the proper distance at which mango trees should be planted, some Indian writers recommending a distance of 6 meters between the trees, 277 trees to the hectare, while some say that only 30 trees to the hectare should be planted, the trees thus being 18 meters apart. Judging from the size attained by the more mature seedling mangos in the Philippines, a distance of 15 meters is not too great. However, the grafted varieties vary considerably in vigor and habit and it is probable that the average distance for grafted trees will ultimately become somewhat less. No mango orchard should be planted out with less than 10 meters between the trees and a distance of 12 to 15 meters is preferable. Aside from varietal variation in vigor, the fertility of the land, prevalence of moisture in the soil, and the amount of precipitation, are factors that should be taken into consideration, when the distance is decided upon, as influencing the development of the trees. It should be kept in mind as well that where it becomes necessary to combat insect enemies or diseases by fumigation or spraying, the trees should stand sufficiently far apart to permit the work to be executed conveniently.

If devoid of natural windbreaks, orchards are usually protected from high winds by the planting of robust, strong-growing trees less easily injured by storms than the fruit trees. The mango is itself, however, so admirably adapted for this purpose that to plant other non-fruiting trees with this end in view would be wasting space, for even if some fruit is lost through the exposure to the wind, more or less will always mature on the tree. For windbreaks only the most vigorous varieties should be planted.

COVER AND SECONDARY CROPS.

The decided benefits derived from the use of cover crops to other fruit trees are of equal advantage to the mango. By adding humus the leaching of fertilizer, particularly nitrates, is prevented during excessive rainfall, the clay soils are rendered more friable and prevented from becoming too compact, the water-holding capacity of sandy soils is increased, and where leguminous cover crops are used, a considerable quantity of nitrogen is added to the soil. Where a leguminous cover crop is wanted, the velvet bean (*Stizolobium deeringianum*), Lyon bean (*Mucuna lyoni*), and cowpea (*Vigna catjang*), and related species may be used with good success in the Philippines. Of these the Lyon bean is preferable in the Philippines since here it produces a greater amount of growth per acre than any other legume. It has been estimated that the green material produced per hectare by the velvet bean (closely related to the native Lyon bean) is 23,950 kilograms, or 6,690 kilograms dry substance; together with the nitrogen stored away in the roots, the gain, if the growth is plowed under, is 160 kilograms per hectare,[68] equivalent to an application of one metric ton of nitrate of soda.

The seed of the Lyon bean and cowpea should be planted preferably in drills to admit of cultivation until the plants are established, 20 liters of seed being sufficient for 1 hectare; 1.8 hectoliters of cowpeas will plant 1 hectare, if sown broadcast.

The considerable distance between the mango trees necessarily leaves much land unoccupied for several years; this may, however, be planted profitably with what is usually called secondary, or catch, crops. These may consist of small quick-growing, early-fruiting fruit trees, pineapples, field, or garden crops. Among trees that may be recommended for this purpose may be mentioned the soursop (*Anona muricata*), sugarapple (*Anona squamosa*), custardapple (*Anona reticulata*), cherimoya (*Anona cherimolia*), guava (*Psidium guajava*), carambola (*Averrhoa carambola*), bilimbi (*Averrhoa bilimbi*), iba (*Phyllanthus distichus*), orange (*Citrus aurantium*), tangerine (*Citrus nobilis*), lime (*Citrus limetta*), and lemon (*Citrus limonum*). These trees should be planted one in the center of each square, or as many in one hectare as there are mango trees. If the mango trees are planted out at the maximum distances, one secondary tree should be planted between each two mango trees and one in the center of the square. Where pitanga (*Eugenia uniflora*) and carissa (*Carissa arduina*) are used as a secondary crop, these shrubs should be planted in rows and may be set out in the interspaces about 1.5 meters apart, maintaining a distance of about 4 meters from a mango to a shrub, and these shrubs being planted in rows between the mangos would not, for many years, inconvenience the planter. Bananas and papayas should be planted about 3 meters apart in the interspaces.

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[68] Fla. Agri. Exp. Station, Bull. 60, 1902, p. 455.

In the subtropical portion of Florida and some parts of the West Indies, many people in setting out a citrus grove frequently plant pineapples in the space between the trees, the pineapples bringing an income to the grower until the trees begin to bear and at the same time serving to shade the ground. As the trees increase in size and require more room, the pineapple plants are torn out and used as a mulch around the trees. This method may be used with equal advantage in establishing a mango orchard.

Corn, sweet potatoes, yams, sincamas, roselle, beans, and in fact any vegetable or field crop to which the land is adapted may be grown in the orchard as a secondary crop without there being the slightest danger of their being injurious to the mango trees, provided that the cultivation is not carried so close to the trees that the work animals injure them or the cultivators tear or break their roots; in fact, it is beneficial in that the constant stirring of the soil aids in rendering plantfood available to the plant that hitherto may not have been available.

By the growing of secondary crops between the mango trees their cultivation is already provided for during the early stages of the development of the grove.

When the trees have grown large and entered their fruiting stage it will be found well to leave the land uncultivated entirely during the dry season except for the stirring in of the fertilizer.

FERTILIZERS.

Cultivation of mangos as so understood by these words in the United States, cannot be said to exist in the Philippines, and no artificial fertilizers have been applied to the mango tree here. It is, therefore, at this date, impossible to give specific recommendations as to what amount to use, as well as which formula and what constituents, based on experience in the Philippines, and we must be guided by the experiences gained in fruit growing in other countries.

The soil in the Philippines is in general sufficiently rich in all elements for the development of trees, in fact it seems to be too well supplied with nitrogen, and the trees in consequence develop foliage at the expense of fruit. To counteract influence of a superabundant supply of nitrogen in the soil it would therefore seem reasonable that better crops of fruit may be produced by the judicious applications of a fertilizer containing potash and phosphoric acid. During the early development of the trees, artificial fertilizer would seem to be an unnecessary expenditure, but when the trees approach fruiting age about 2 kilograms may be applied twice a year to a tree having a crown diameter of about 3 meters, making the applications about September 1 and January 1, and increase or decrease the amounts applied as the trees increase in size and according to the behavior of the trees. The reason for the use of artificial fertilizer being to force the trees to bloom and fruit rather than to improve its quality, fertilizer need not be applied during the early part of the year. The following formula is tentatively recommended: Potash 10 per cent, phosphoric acid 8 per cent. In mixing the fertilizer high grade sulphate of potash may be used at the rate of 225 kilograms and superphosphate at the rate of 450 kilograms. Being a highly concentrated fertilizer, this mixture containing 675 kilograms is equivalent to one metric ton of ordinary fertilizer with approximately the analysis here recommended and should be applied accordingly. If low grade sulphate of potash is used instead of the high grade, twice the amount of this constituent should be applied in order to get the same results.

During the first few years after the trees have been set out, stable manure, well decomposed, applied to the trees would considerably hasten their development, but when the trees are of fruiting age it is better to use it only on very poor soils.

COMPOSITION AND USES OF THE FRUIT.

The mango being a dessert fruit used in the fresh state or preserved, its chief digestible constituent is sugar; the protein content is low. Mr. H. C. Gore, of the Bureau of Chemistry, United States Department of Agriculture, has made the analyses in Table I, the material for which was sent to him from Florida by the author. To compare the analysis of the Florida mangos with those grown in other parts of the world, extracts of Table V in Bureau of Chemistry Bulletin No. 87, 1904, have been appended as Table II.

TABLE I.

Variety.	Weight, per fruit.	Pulp.	Total sugar as invert.
	Grams.	*Per cent.*	*Per cent.*
Mango "No. 11"	215.0	84.81	8.87
Mango "Apricot" or "Bombay"	266.0	87.59	12.92
Mango "Turpentine"	138.0	82.27	10.28

TABLE II.

Variety.	Average weight.	Edible portion.	Total sugar.
	Grams.	*Per cent.*	*Per cent.*
French mango	124.0	55.6	13.09
Manzana (apple) mango	86.0	48.0	9.84
Filipino mango	255.0	77.7	17.74
Do	190.0	75.5	15.48
Manga	126.0	66.8	14.69
Jamaican mangos:[69]			
No. 11		69.9	12.11
Yam		55.2	9.16
Bombay		65.1	12.78
Black		53.5	15.09

The mango in the Tropics takes the place of the apple in the Temperate Zone, and justly so. The favor with which the mango is regarded in the Tropics may be taken as an indication of its coming popularity in the Temperate Zones when the better class of mangos are once introduced. In some parts of Spanish America the mango is eaten with the aid of a three-pronged fork having one long central tine that penetrates the seed, and two shorter ones that prevent the seed from turning. The fruit of the fiberless varieties may be served in halves, or the skin may be cut transversely near the tip and also near the base and then by making a longitudinal cut connecting the others, the skin is easily peeled off; this leaves the flesh exposed and yet allows the fruit to be held in the hand without soiling the fingers.

Excellent mango sauce, very similar in flavor to that made from the apple, may be made from the full-grown immature mango. It is prepared by peeling the fruit, slicing the flesh, and boiling it together with a little water, adding sugar to taste.

The following formulas for jelly and marmalade have been furnished by Mrs. Cora Ormsbee Scales, Miami, Florida:

JELLY.

Peel the mango as it begins to turn yellow, before it softens; slice the pulp from the seed; pour enough water in the pan to cover the fruit, and boil until quite tender; strain through muslin cloth; to this juice add an equal quantity of sugar and boil till it jellies. Lime juice may be added if more acidity is desired in the jelly than is present in the mango.

MARMALADE.

The pulp left after the juice has drained off in making jelly is now run through a fine sieve; boil with an equal quantity of sugar, adding a little lime juice to make it firm, until it thickens like cheese. (Marmalade, of course, can also be made direct from the fruit, i. e., with its own juice retained.) It has been stated that if the mango seed is boiled together with the preserve, the preserve will retain the flavor of the fresh mango. The seed, of course, is thrown out when the preserve is put up in jars.

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[69] H. G. Cousins, Bull. Dept. of Agr. Jamaica, 1903, vol. 1, Pt. II, p. 263.

MANGO PRESERVES.

Select mangos just showing color; peel and slice; to each kilogram of fruit use 1 kilogram of best white sugar and 2 teacups of water; boil the sugar and water until it drops from the spoon very heavy, then pour over the fruit and let stand until cold. Pour off the sirup and boil down as before; when the sirup is quite thick, drop in the fruit and boil hard for twenty minutes, or until the sirup remains thick. Seal at once.

CANDIED MANGOS.

Select the mango just showing color; peel and cut from the seed in large pieces; use 1 kilogram of sugar and 2 teacups of water for every kilogram of fruit; boil the sirup and pour over the fruit, letting it stand two or three hours; then put on the fire and bring all to a boil; let stand over night; next morning pour off sirup and cook till it threads; pour over fruit again and let stand till next day. Repeat this process every day for three days, in which time the fruit will have absorbed all the sugar it can take. On the fourth day drain off the sirup and cook till it threads, drop in the fruit and boil about five minutes, very hard; drain off all the sirup, using a porcelain colander; when the fruit is dry lay on plates in a hot, airy place, in the shade, until it is well dried and cover it with a thin cloth. If these directions are followed carefully, the fruit will keep for years and will not sour or mold.

CHUTNEY.[70]

Take 3 kilograms of pulp of the common mango (turned but not ripe), 3 kilograms tamarinds, 2 kilograms raisins (weighed after stoning), 8 kilograms brown sugar, 0.5 kilogram chilies, 2 kilograms green ginger, 0.5 kilogram garlic, or 1.5 kilograms onions, 0.25 kilogram mace, 65 grams mustard seed, 15 grams cloves, 15 grams pimento, 0.5 kilogram table salt. Soak the tamarinds in 4 liters of the best vinegar, stir them about with a wooden spoon to get the pulp off, and take out the seeds. Cut the raisins small. Peel the ginger and grate it. Pound the chilies, garlic, and mustard seed in a mortar, using a little of the vinegar for moistening. Mix all together thoroughly with the mango pulp. It is then ready for use.

As a pickle the mango was at an early date known in India. Ibn Batuta noted it thus prepared in 1332. In that country, where the mango is an important staple of food, the fruit is utilized in many ways, immature and ripe.[71]

When green, the stone is extracted, the fruit cut into halves or slices, and (*a*) put into curries; (*b*) made into a pickle, with salt, mustard oil, chilies, and other ingredients; (*c*) made into preserves and jellies by being boiled and cooked in sirup; (*d*) boiled, strained, and with milk and sugar made into a custard known as "mango fool;" (*e*) dried and made into the native "ambchur," used for adding acidity to certain curries; (*f*) when very young cut into small pieces, mixed with a little salt, and sliced chilies and milk added, it forms a "tasty" salad.

When ripe (*a*) it is made into curry which has a sweet, acid, not unpleasant taste; (*b*) it is cut into small pieces and made into a salad with vinegar and chilies (the sour fruit is sometimes so used); (*c*) the juice is squeezed, spread on plates, and allowed to dry; this forms the thin cakes known as "amb-sath." The kernels are eaten in times of famine, and by the poorer classes in many parts of India they are boiled and eaten as greens. They are also ground with meal and mixed with various other ingredients to form a relish known as "am-katai." When stuffed with corhiander, turmeric, and other spices and boiled in mustard oil, they are esteemed a great delicacy.

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[70] Bull. Bot. Dept. Jamaica, No. 46. (The figures have been converted into the metric system.)

[71] Watt, G., Dictionary of Eco. Prod. of India, 1891, Vol. V, p. 155.

OTHER USES OF THE MANGO.

While the mango is not accredited with having recognized medicinal properties, in India it is largely prescribed by the natives for many and varied diseases and numerous medical authorities speak highly of its uses.[72]

The bark and seed contain tannin, the former having analyzed 16.7 per cent. In some parts of India the bark and leaves are used in the manufacture of dyes. An account is given by Collins [73] of a method where a coloring matter is obtained from the mango leaves, indirectly by feeding them to cows whose urine is collected and made into coloring material.

The wood is fairly durable if not exposed to water, but is liable to be attacked by insects.

MARKETING.

The marketing of the fruit is a problem of great importance, the failure or success of the production of the mango as a commercial undertaking depending largely on the successful solution of this problem. Where the fruit is handled properly it seems that its shipping qualities are very good, fruit shipped from the West Indies to England and France, and even from India to London, arriving in good condition. The tomato crate is commonly used in Florida in shipping mangos, and seems to answer the purpose well. Ventilated crates 30 by 30 by 60 centimeters containing a dividing board in the center and 2 trays of a thin board to distribute the weight would probably be found to be a suitable package in the Philippines. Great care should be exercised in the handling of the fruit from the time it is picked until it is packed, in order to reduce the number of spoiled fruits to a minimum. Each fruit should be wrapped in soft tissue paper before it is put into the package and care should be taken to see that no fruits can move about after the crate is nailed up.

In India the fruit is picked before it is fully mature, and ripened in straw.[74]

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[72] Collins, G. N., B. P. I., U. S. D. A., Bull. 28, 1903, p. 23.

[73] Collins, G. N., B. P. I., U. S. D. A., Bull. 28, 1903, p. 24.

[74] Simmonds, P. L., Tropical Agriculture, 1889, p. 485.

THE EMBRYONY OF THE MANGO.

The seeds of most plants are always monoembryonic, i. e., each seed produces only one plant, but in some plants like the orange (*Citrus aurantium* L.), the tangerine (*Citrus nobilis* Lour.), and the yambo (*Eugenia jambos* L.), the seeds are also frequently polyembryonic; in these species one seed may contain several embryos, each of which, under favorable conditions, is capable of producing a plant. The mango (*Mangifera indica* L.) is both mono- and polyembryonic, the seeds of the latter type frequently producing six to eight plants, and as many as thirty have been observed to come from one seed.

As far as the author is aware the polyembryony of the mango seed was earliest discussed at some length by Reinwardt nearly a century ago.[75] In fact, Gaertner had already noted the peculiar structure of the mango seed, but he was probably not aware of its significance. Reinwardt's paper was accompanied by a colored plate illustrating the polyembryonic character of the seed and he also mentioned the occurrence of monoembryony among the cultivated varieties. Later references to the polyembryony of the mango have been made by Schacht,[76] Strassburger,[77] and Cook,[78] but the monoembryonic character of the seed of this species seems to have been lost sight of, or at least no importance attached to this feature.

In Florida the observation has been made that the seedling types, all being polyembryonic, transmit their characters to their progeny in a remarkable degree; i. e., "come true to seed." Of course, variation exists but the main characters of a type are well reproduced. This feature of "reproduction of type" of the inferior seedling varieties has also been noted in Jamaica, contrary to the habit of the imported grafted varieties from India, whose progeny is very variable.[79]

The types grown in the Philippines, popularly but incorrectly called varieties, are also polyembryonic and thus, as is well known, reproduce their racial characteristics to a remarkable degree.

A most interesting account of an investigation on the formation of the embryo in the mango is found in the Report of the Florida Agricultural Experiment Station for 1908, pages 109 to 125, accompanied by several illustrations. Belling, the investigator, in an examination of fruits from two trees of a seedling type (polyembryonic) in Florida, discovered *no formation of embryos from the germ-cells* in the ovaries and all the embryos seen were *adventive.*

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[75] Acad. caes. leop. carol. nova acta, 1825, Vol. XII, pp. 343–346.

[76] Madeira and Tenerife, 1859, p. 53.

[77] Jenaische Zeitsch. Naturwiss., 1878, Vol. XII, pp. 652–657.

[78] Torreya, 1907, Vol. VII, No. 6, pp. 115–116.

[79] Bull. Bot. Dept. Jamaica, 1901, Vol. XIII, p. 165.

In juxtaposition to this characteristic of the polyembryonic types (to reproduce themselves true to seed) the progeny of the monoembryonic varieties of India seem to be very variable; and there appears to be but little doubt that the species may be divided into two great divisions, one containing the polyembryonic mangos, whose progeny retain the racial characters of the parents, the other, the monoembryonic varieties from India, whose progeny is variable.

BREEDING.

With so many excellent varieties already in cultivation it would seem that very little is left for the plant breeder in the way of improvement. In respect to quality this may be true, but certainly much can yet be done to reduce the size of the seed, if it cannot be eliminated. It is much to be desired also that crosses be made between the well-flavored varieties and the ever-bearing types, in the hope of originating varieties of good quality that will produce fruits for a more prolonged season of the year than is now the case. Novel and pleasing fruits might also result from certain bigeneric crosses: for instance, with the cashew and several species of *Spondias,* or the pistach.

DISEASES.

In the mango there is an enormous discrepancy in the number of flowers produced and the fruit that matures, mainly due to the fact that a large majority of the flowers are staminate. There are, however, several other agencies that determine the productivity of the tree if it otherwise is of a prolific character. In Jamaica, for instance, where the variation in humidity, precipitation, and soil conditions is quite marked in different localities it has been noted that the mango—in all instances blooming profusely—is most productive on the low, dry, limestone hills, where it produces enormous crops, sometimes twice yearly; in humid districts on the northern coast it is less productive, except during very dry years; in the wet districts it rarely fruits.[80] This failure to set fruit may be due to excessive humidity or precipitation during the blooming period, but the cause is more probably the mango blight fungus, which was identified by P. H. Rolfs as *Colletotrichum gloeosporioides* Penzig. This pest, under certain conditions, is very destructive to the

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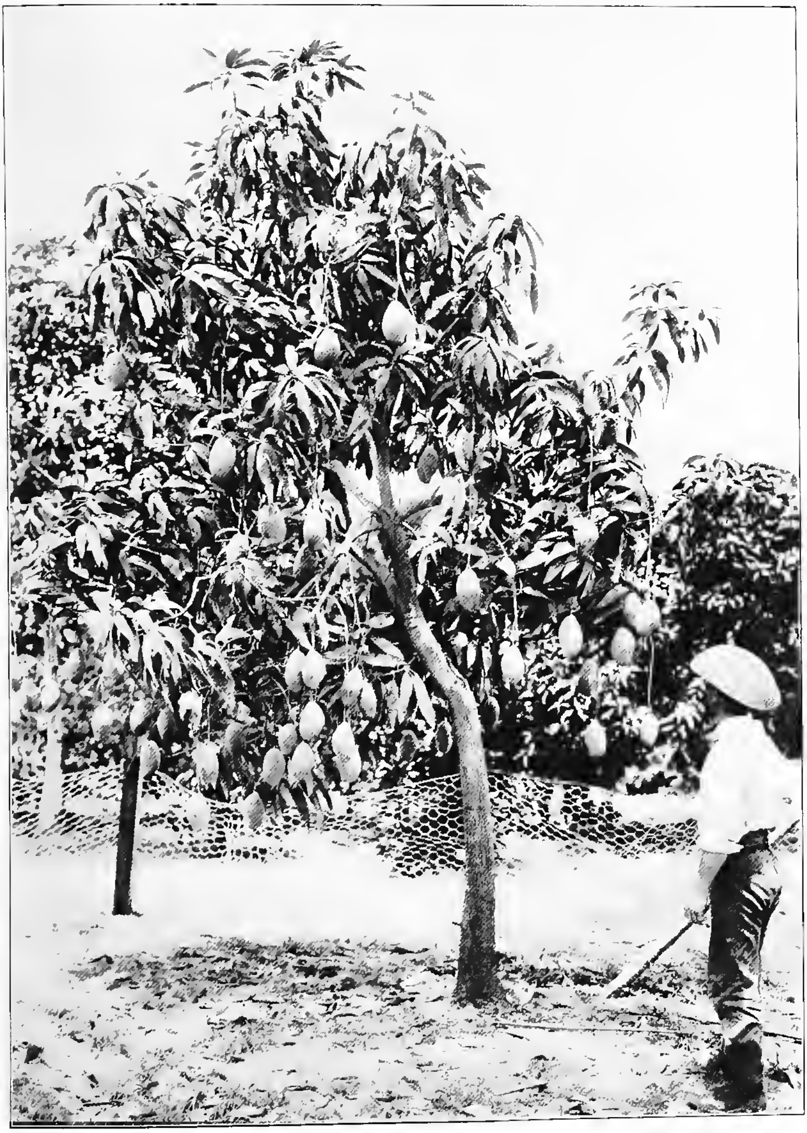
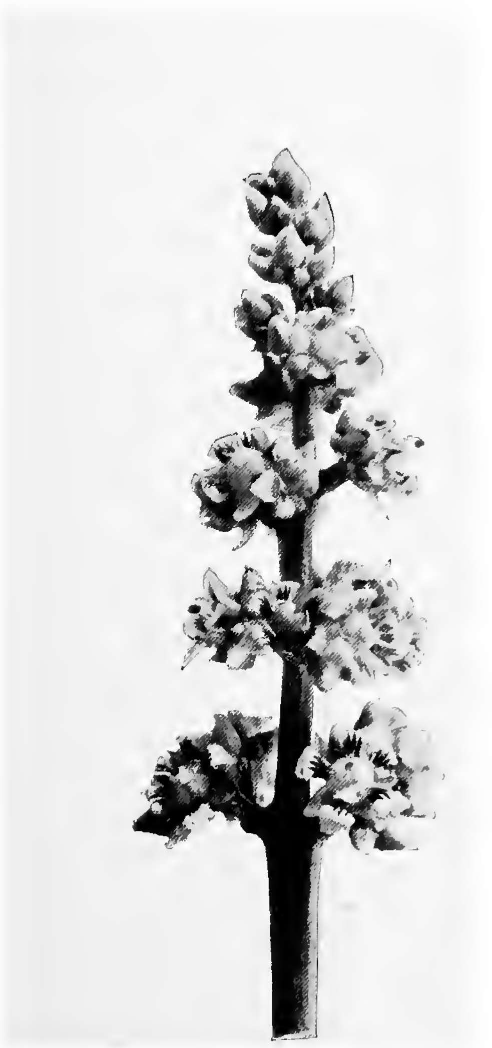
[80] Bull. Bot. Dept. Jamaica, 1901, Vol. VIII, p. 165.



YOUNG TOPWORKED MANGO TREE (SANDERSHA), MIAMI, FLORIDA.

(Budded October, 1904 ; photographed, 1909. The tree bore a crop of 40 well-developed fruits, averaging 575 grams in weight in 1907.)



MANGO FLOWERS (TWICE ENLARGED).

mango bloom. Experimentation disclosed the fact that the fungus is readily controlled by the use of Bordeaux mixture; the discovery of this remedy was announced in the Florida Agriculturist, April 3, 1907, by the author, and it has since been successfully used by the mango growers in Florida.[81]

Although a cosmopolitan species this fungus has not yet been reported in the Philippines; it may be discovered here at any time, however. To secure full benefit of the treatment, the flower panicles should be sprayed when the earliest flowers make their advent. The spraying should be repeated in the course of two or three weeks, particularly if the blooming season is wet and rainy. It is not necessary to apply the spray to the foliage and the branches. Great care should be taken that the mixture is properly made since otherwise more harm than benefit might result from its application. As a matter of fact, there are always a number of newly opened flowers that are destroyed by the spray, but this loss is counterbalanced by the large number that are saved and enabled to set fruit.

During the wet seasons the same fungus does considerable damage to the fruit, causing it to turn black, spotted, or streaky, which detracts from its appearance, shipping and keeping qualities. The fungus attacks the foliage also. There seems to be considerable variation in the susceptibility to this trouble among the different types of mango, some being nearly immune. This evil also is controlled by judicious applications of Bordeaux mixture.

Except for the mango blight, the full-grown mango seems to be remarkably free from diseases. The damping-off and mildew that attack young plants in the nursery have already been referred to under the chapter on propagation.

INSECTS AFFECTING THE MANGO.

The problem of insect control is a large factor in successful fruit culture. Wherever large orchards of a fruit are planted, the balance of nature is disturbed and an artificial condition is created. Insects that prove comparatively harmless under natural conditions, when the trees of one species are interspersed with those of another, making difficult the transmigration from tree to tree and the food supply scarce, may prove destructive and dangerous pests in an orchard where ideal conditions prevail for their multiplication, by reason of an abundant food supply and facile means of migration from tree to tree.

The different parts of the mango tree are affected by a number of insects. So far, however, the majority of these have not been reported to seriously injure the plant perhaps because they in turn are, in many instances, themselves the prey of predaceous insect or fungus parasites which prevent their rapid multiplication.

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[81] Directions for the preparation of Bordeaux mixture are given on page 57.

The insect pests that hitherto have appeared to be of primary importance are those that attack the fruit, seed, and the inflorescence of the mango. The scales and biting insects seem to have been less destructive; some injury is caused by borers.

Perhaps the most serious insect pests of the mango are the fruit flies, of which three species are particularly conspicuous: the mango fruit fly (*Dacus ferrugineus* Fabr.), the Queensland fruit fly (*Dacus tryoni* Froggatt), and the Mexican fruit fly (*Trypeta ludens* Loew.).

The mango fruit fly is found in India, Ceylon, Java, and Amboina, where it is very destructive to the mango, and it probably occurs in many other islands in Malaysia as well. The species also infests the orange and other fruits.

The Queensland fruit fly ranges from India and Ceylon to Java, Amboina, and Australia (Queensland and New South Wales). It is commonly a mango pest, but is also destructive to bananas, oranges, peaches, and other fruits.

Both of these species, in the adult stage, are small, active flies that lay their eggs on the fruit in which the larvæ burrow, rendering them unfit for consumption. Having attained their full size the larvæ leave the fruit and pupate in the ground. The fruit flies have been reported to be especially destructive to the mango in Java. Over 50 species of the genus *Dacus* have been described from Malaysia, and it is probable that several of these, beside the two species that are particularly conspicuous mango pests, are more or less injurious to the mango.

A fruit fly hitherto unidentified, probably a species of *Dacus*, was discovered infesting the mango in Bataan, Rizal, Cavite, and Bulacan Provinces during the past year, that works considerable destruction to the fruit. It is to some extent held in check by the numerous hogs that devour the fallen fruit.

The Mexican fruit fly appears to be the only serious mango pest in the Western Hemisphere. This insect is thought to be of South American origin, but it is its attacks on the mango, orange, and guava, in Mexico, chiefly in the State of Morelos, that have made it known as a serious insect pest. The small fly lays the eggs in the peel of the nearly ripe fruit, and the larvæ behave in the same manner as do the larvæ of the other fruit flies. The larvæ usually leave the fruit and pupate in the ground, though occasionally the chrysalis stage is passed in the fruit.

The fact that the species enumerated all infest other fruits than the mango renders them the more dangerous and correspondingly difficult to control.

Remedies: The fruit flies may be controlled to some extent by gathering and burning all "drops" and refuse fruits before the larvæ leave and enter the ground to pupate.

Mr. C. W. Mally, of Cape Colony, South Africa, has found that poisoned bait [82] may be used very effectively in combating the Mediterranean fruit fly (*Ceratitis capitata* Weid.), so destructive to the fruits of that country, and there is every probability that it would, on trial, be found equally effective in the destruction of all the fruit flies affecting the mango, provided that they are attracted to sweet substances like the Mediterranean and Mexican fruit flies. In the course of his experiments with this spray, Mally found that the percentage of infested fruit dropped from 50 per cent in unsprayed trees to 1 per cent in those that were treated. According to Mally, bees are not attracted by this bait, and there is no danger of poisoning from eating the fruit from the trees sprayed.

Mally recommends that the first application be made a month before the presence of the larvæ in the fruit is expected, and thereafter an application every ten to fourteen days is thought advisable. The aim should be to have the poisoned bait on the trees so long as the flies are present in the orchard. A comparatively small amount of the spray is applied to each tree, or about 1 to 1.5 liters to a tree of about 6 to 7.5 meters spread.

In applying the spray the nozzle should be directed so that the liquid shall fall in small drops over and through the tree.[83]

Another serious pest of the mango is the mango hopper, the vernacular name for three species of homopterous insects—*Idiocerus atkinsonii* Leth., *I. clypealis* Leth., and *I. niveosparsus* Leth.—which some years in certain parts of India are reported to reduce the mango crop to one-third of its normal value. These insects, which are found on the mango throughout the year, do not occur as an annual pest, but appear in great numbers every few years at the flowering season, when the principal injury is made. The insect is a small, dark, wedge-shaped "hopper," that jumps or flies short distances. The eggs are apparently laid on the tender flower panicles, where they hatch, and the larvæ as well as the adults, blight the bloom by sucking up the juices that should assist in the formation of the flowers and fruit. The two last mentioned of these species of this genus were discovered in Cavite and Rizal in April, 1911,and have since been observed in several other provinces as well; as far as known it has not yet appeared in Cebú.

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[82] See formula No. 8, page 59.

[83] Agr. Journal Cape of Good Hope, 1909, vol. 34, pp. 620–623; vol. 35, pp. 578–581.

Certain years when these insects appear, as they do in enormous numbers at the time of the flowering of the mango, they frequently destroy the crop for that season.

Remedies: Spray experimentally with formulas Nos. 2, 3, or 4, of gradually increased concentration.

The mango-weevil (*Cryptorhynchus mangiferæ* Fabr.) has spread with the dissemination of the mango until now it is found in Malaysia, certain parts of India, South Africa, Hawaii, and probably also in some of the islands of Oceania. This insect was reported from the Philippines but has never been noted here by any of the officers of the Bureau of Agriculture. The injury caused by this insect is primarily the destruction of the seed. Sixty to ninety per cent of the fruits have been reported to be infested in countries where it has established itself; fortunately, however, the pulp of the fruit is not attacked, and is still fit for consumption, except where several larvæ infest one fruit. The weevil is 7.5 millimeters long and 4.25 millimeters broad and dark brown in color with buff markings, with a broad, almost white median longitudinal line on the thorax. The peculiar roughened surface, together with the markings, produce a decided protective coloration when the insect is hiding among the débris and in the earth. Like most weevils it feigns death when disturbed. Van Dine, who has made a study of the mango-weevil in Hawaii, says:

> "When as many as three or four larvæ occur within one seed, the resulting decay from their excrements and the seed extends through the bark, in some instances to the flesh. Some growers are of the opinion that the work of the weevil hastens the maturity of the infested fruit and increases the percentage of the fallen mangos."[84]

The egg is laid on the half or two-thirds grown fruit and the larva bores through the flesh without visible injury and enters the seed. The full-grown adult does not emerge from the seed until some time after the fruit has ripened.

Remedies: For the reasons stated the destruction of all fallen mangos and refuse seeds will effectually restrict the multiplication of the insect. The mango-weevil is not known to breed on any other fruit, and it should thus be possible to eradicate it by destroying the fruit in infested districts for two years.

Of the *Physopoda,* two species of thrips, the green-house thrips (*Heliothrips hæmorrhoidalis* Bouche), a small, black insect, and the red-banded thrips (*H. rubrocincta* Giard.), in its immature stage recognized by a red, transverse band across the abdomen, have been reported as injurious to the mango. The thrips are gregarious, sucking insects that inhabit the under side of the leaf, also attacking the young twigs when they are very numerous. The injury is caused by the puncturing of the tissues and sucking out the juice, with the effect that the trees drop their leaves if measures are not taken to destroy the insects. The thrips also attack the guava and many other plants.

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[84] Hawaii Agr. Exp. Station, Press Bull. 17, 1906, p. 9.

Remedies: Spray with formulas Nos. 2, 3, or 4.

The red spider, or purple mite (*Tetranychus mytilaspidis*), a minute, reddish, or reddish-purple, sucking insect, sometimes attacks the foliage of the mango during the dry season, but usually disappears with the approach of the rainy season.

Remedies: Where the insects appear in injurious numbers apply formulas Nos. 2 and 3.

The species already discussed are considered to be the more important insect pests of the mango. Those referred to below have not as yet been recorded as serious pests.

Hemipterous insects affecting the mango are more numerous than those from any other order. The mango hopper has already been discussed. A fly (*Psylla cistellata* Buck), occurring in India, lays its eggs in the terminal buds of the mango, where the larvæ feed on the tender tissues and destroy them.

Remedies: The damage done by this insect in India does not appear to have assumed such dimensions as to call for direct measures for its control. The pruning and burning of all twigs affected should prove effective. If this insect were introduced into the Philippines and if it were to find native species of plants congenial for its breeding habit, like the lepidopterous larvæ described in the Philippine Agricultural Review (1911, Vol. IV, No. 6, pp. 313–314), it might become a serious pest and its control prove a difficult problem.

Numerous scale insects have been reported attacking the mangos in practically all countries in which it is grown. For convenience the scales are divided into two groups, (*a*) armored,[85] and (*b*) unarmored;[86] the former are more or less protected by a waxy excrescence, while the latter are usually naked and thus more readily controlled by the means of sprays.

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[85] The following armored scales have been recorded as affecting the mango: *Aspidiotus cocotiphagus* Marlatt, *A. destructor* Sign., *A. hederæ* (Vull.), *A. trilobitiformis* Green, *A. mangiferæ* Ckll., *Aulacaspis rosæ* Bouche, *Chionaspis vitis* Green, *Chrysomphalus aonidum* (Linn.), *C. personatus* Comst., *C. distyospermi* Morg., *C. mangiferæ* Ckll., *Hemichionaspis aspidistræ* Sign., *Leucaspis indica* Marlatt, *Morganella longispina* (Mask.), *Parlatoria mangiferæ* Marlatt, *Phenacaspis dilatata* (Green), *P. natalensis* Ckll., *P., eugeniæ* (Mask.), *Pinnaspis buxi* (Bouche), *Pseudaonidia trilobitiformis daryuti* de Charm., *P. articulatus* (Morg.), *Pseudichenaspis longissima* (Ckll.).

Many of these species are parasitic on other plants than the mango and several are found in the Tropics of both hemispheres; no species, however, so far as the writer is aware, has as yet appeared as a serious pest. This, however, affords no excuse to the importers of propagation material of the mango for relaxing their vigilance in regard to those insects, for no one can predict the future career of an insect in a new environment or in a climate which may be far more favorable for the multiplication of the insect than that to which it is indigenous, and where usually an equilibrium of nature has been established which frequently prevents it from becoming a serious pest.

Remedies: Fumigation or spraying with formulas Nos. 2, 3, 4, or 5.

There are two unidentified species of *Lepidoptera*, the larvæ of which work considerable destruction to the mango—one that enters the young tender terminal growths and hollows them out after which they wither and die; another larva, probably the same species, has in the flowering season been found to work much destruction to the mango flowers—and considerable damage to the mango flowers is also caused by a larva that feeds on the surface of the flower stems with the effect that they shrivel and die. These insects, as yet unidentified, are, together with *Idiocerus clypealis* Leth., *Idiocerus niveosparsus* Leth., and the unidentified fruit-fly (already referred to on a previous page), the principal, and as far as known at present, the only serious insect pests on the mango in the Philippines.

The larvæ of the following *Lepidoptera* have been found to defoliate the mango trees in India: *Cricula trifenestrata* Helfer, *Leucoma comma* Hutton, *Natada velutina* Koller, *Euproctis limbata* Butler, *E. lunata* Walker.

Where it has appeared in large numbers, the last species mentioned is reported to have destroyed practically all the fruit as well as a large portion of the foliage. Any of those species may appear in the Philippines at any time.

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[86] The following unarmored scales have been recorded on the mango: *Asterolecanium pustulans* (Ckll.), *Ceroplastes ceriferus* Anderson, *C. floridensis* Comst., *C. rubens* Mask., *Coccus mangiferæ* Green, *C. acuminatus* (Sign.), *C. hesperidum* (Linn.), *C. longulus* (Dougl.), *Icerya minor* Green, *I. purchasi* Mask., *Llaveia axin* Llave, *Monophlebus stebbingi mangiferæ* Green, *M. stebbingi octocondata* Green, *Phenacoccus mangiferæ* (Green), *Pseudococcus iceryoides* Green, *P. longispinus* (Targ.), *Pulvinaria psidii* Mask., *P. ficus* Hemp., *P. mammeæ* Mask., *Saissetia psidii* (Green), *S. oleæ* (Bers.), *Tachardia lacca* (Kerr.), *Trionymus americanus* (Ckll.), *Vinsonia stellifera* (Westw.).

Remedy: Hand-picking and spraying with formulas Nos. 6 or 7.

Aside from the *Coleopterous* insects, already referred to on previous pages, *Diapromorpha melanopus* Lacord., has in the adult stage been reported to injure the young growth of the mango in India.

Remedy: Jarring the trees and collecting the insects. Spraying with solution Nos. 6 or 7.

The study of many of the insects affecting the mango appears to be a neglected field, and much work remains to be done by future entomologists. In proportion as our knowledge of their life-history increases we may expect to control, perhaps even eradicate them.

INSECT CONTROL.

If the insects assume the character of a pest in the mango orchard, measures must be taken for their control; failure to do this frequently means that the difference between profit and loss must be entered on the wrong side of the ledger. This may be done by spraying, fumigation, or by the jarring of the trees and gathering and burning the fallen insects (when the enemy is a beetle or caterpillar). A study of the life-history of an insect pest may reveal that it can be cheaply and effectively controlled by parasitic fungi or insects, or by predaceous insects; and the appearance of insect pests in the orchard should, therefore, be reported to the Director of Agriculture.

SPRAYING AND FUMIGATION.

In order to be effective, the spraying should be thorough and the application liberal. The pressure should be sufficient to cause the spray to settle on the trees as a fine mist and not in large drops. All the sprays recommended, except formulas Nos. 4, 5, 6, 7, and 8, have been used by the author without injurious effects on the mango when the flushes were matured. In the temperate regions, the self-boiled lime-and-sulphur wash, as a combined fungi- and insecticide, is to a certain extent beginning to displace Bordeaux mixture and various contact sprays, and it is reasonable to believe that this spray is also valuable in control of fungi and insect pests on the mango. Among the sprays for biting insects on deciduous fruits arsenate of lead (formula No. 7) is taking the lead, and may prove equally effective in destroying similar insects on the mango. It is improbable that the resin wash (formula No. 4) and Paris green (formula No. 5), which are used so successfully in the warfare against certain insects without injury to the plants sprayed with these mixtures, would prove injurious to the mango if the sprays are prepared properly. However, it is well in using sprays that have not been experimented with on the mango, to spray a few trees and wait a few days to see if any ill effects appear before spraying the whole orchard.

For the owner of a few mango trees a "knapsack" or compressed-air sprayer that can be carried on the back by a man is large enough, but the small orchardist will find a barrel spray mounted on wheels, with 15 to 20 meters length of rubber hose attached, 13 millimeters in diameter, the most convenient. The "Vermorel" is preferable to other types of nozzles. It is important that the spray mixture is well strained so as to prevent the nozzle becoming clogged in the act of spraying. It is well to remember that the copper sulphate and the arsenites are very poisonous and should not be left where they are accessible to children or domestic animals.

The effect of all oily sprays is to smother the breathing pores of the insects. In fumigation the insects are killed by the generation of hydrocyanic acid gas under a gas-tight tent covering the tree. For the fumigation of small trees in the nursery a tent or an airtight box may be made, and the ingredients used according to the following formula (for 5 cubic meters[87]):

Cyanide of potassium,[88] C. P. (96 per cent)	grams	50
Sulfuric acid, 66 per cent	centiliters	5
Water	do	15

Insect control by means of fungi is possible only in regions possessing a moist climate and a rainy season long enough for the development of the fungi. In Florida the San José scale on the peach, and certain scales and the white fly affecting the citrus trees, are to a certain extent controlled by the presence of parasitic fungi. There as well as in California certain insects are kept in control by parasitic and predaceous insects. The success that has attended this method in both these States is an indication of what might be accomplished in the control of insects affecting the mango. In order to do this successfully it is necessary that the pest be present in sufficiently large numbers to enable the controlling agent to become established.

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[87] For the conversion of metric to common measures, see computation tables on pages .

[88] The cyanide of potassium should first be weighed out and placed in a small paper bag. The water is then measured and placed in a vessel, preferably of glazed earthenware, and the acid is added, after which the vessel is placed inside the tent; the cyanide of potassium is now dropped into the liquid and the tent quickly closed. Open after thirty minutes. The cyanide of potassium and the gas generated are both fatally poisonous and should be handled with great care.

FORMULAS FOR FUNGICIDES AND INSECTICIDES.

1. BORDEAUX MIXTURE.

For fungi.

Copper sulphate	kilograms	1.5
Unslaked lime	do	1
Water	liters	100

Place the copper sulphate in a feed sack and suspend it in a barrel containing 50 liters of water so that the sack is just covered by the water. Slake the lime in another vessel and when slaked dilute to 50 liters. Before mixing stir the two solutions vigorously. Then dip a bucket from each solution and pour the two liquids together in the spray barrel, at the same time agitating the mixture vigorously. An excess of copper sulphate is injurious to the foliage, and before spraying the mixture should therefore be tested. This is done by inserting and holding in the mixture a clean steel blade for one or two minutes. If copper is deposited on the blade, more lime must be added. Use the mixture at once.

2. GOOD'S CAUSTIC POTASH WHALE-OIL SOAP.

For scale and sucking insects.

Whale oil soap	kilograms	3–6
Water	liters	100

3. KEROSENE EMULSION.

For scale and sucking insects.

Kerosene	liters	7.5
Hard soap	kilogram	.25
Water	liters	4

Dissolve the soap in boiling water and while still very hot add the kerosene. Churn the liquid steadily for fifteen or twenty minutes by using a force pump, the liquid being pumped back into the vessel until it is emulsified. Sufficient hot water should be added to make the solution to 16 liters. For spraying dilute at the rate of 1 liter of the emulsion to 15 liters of water.

4. RESIN WASH.

For scale and sucking insects.

Resin	kilograms	9
Caustic soda (98 per cent)	do	2.25
Fish oil	liters	1.5
Water	do	75

Pour 75 liters of water over the resin (which should be well broken up) caustic soda and fish oil in a large iron kettle, and boil for three hours. Then add hot water from another boiler (which should be provided for this purpose) from time to time, and stir thoroughly until there are 190 liters of the solution. If desired for immediate use, dilute each liter of the solution with 2 liters of cold water before using. If kept as a stock solution, it should be diluted at the same ratio when used.

5. SELF-BOILED LIME-SULPHUR WASH.

For fungi and scale.

Quicklime	kilograms	3
Sulphur (flour or flowers)	do	3
Water	liters	100

Place the lime in a barrel and pour on enough water to cover it. When the lime begins to slake, add the sulphur after running it through a sieve to break the lumps. Stir the mixture constantly and add water as needed to form a thick paste at first, and then gradually a thin paste. The lime will supply enough heat to boil the mixture several minutes. As soon as the lime is well slaked add water to cool the mixture and prevent further cooking. Strain carefully, working the sulphur through the strainer, and dilute to 100 liters.

If it is desired to make the spray efficient against biting insects, Paris green, London purple, or arsenate of lead may be added to the lime-sulphur wash at the same rate as recommended in formulas Nos. 6 and 7.

6. PARIS GREEN.

For biting insects.

Paris green	grams	60–120
Quicklime	kilograms	0.5–1
Water	liters	100

Place the lime in a wooden vessel and slake, dilute to 100 liters, and add Paris green. London purple may be substituted for Paris green and used at the same rate. Both these poisons, particularly the Paris green, have a tendency to settle and the liquid should be kept in constant agitation during the spraying, else the spray from the bottom of the barrel may seriously damage the foliage while the rest is useless.

Paris green, London purple, or arsenate of lead may be used in combination with Bordeaux mixture. They are then added as if the Bordeaux mixture was water.

7. ARSENATE OF LEAD.

For biting insects.

Arsenate of lead	kilogram	0.5–1
Quicklime	do	0.5–1
Water	liters	100

Slake the lime in a wooden vessel, dilute to 100 liters and dissolve the arsenate of lead in the liquid.

8. THE MALLY FRUIT-FLY REMEDY.

Arsenate of lead	kilogram	0.6
Sugar	do	7.5
Water	liters	100

Dissolve the arsenate of lead in a small quantity of water, dilute to 100 gallons and add sugar.

COMPUTATION TABLES.

METRIC MEASURES AND THEIR EQUIVALENTS IN COMMON MEASURES.

Length.

Name.	Meters.	Common measures.
1 hectometer	100	328 feet.
1 decameter	10	32.8 feet.
1 meter	1	3.28 feet.=39.37 inches.
1 decimeter	0.1	3.93 inches.
1 centimeter	0.01	0.39 inch.
1 millimeter	0.001	0.03 inch.

Area.

Name.	Square meters.	Common measures.
1 hectare	10,000	2.471 acres.
1 are	100	119.6 square yards.
1 square meter	1	1,550 square inches.

Capacity.

Name.	Liters.	Common measures.
1 hectoliter	100	26.417 gallons.
1 decaliter	10	2.6417 gallons.
1 liter	1	1.0567 quarts.
1 deciliter	0.1	0.845 gills.
1 centiliter	0.01	0.338 ounce.
1 milliliter	0.001	0.27 dram.

Weight.

Name.	Grams.	Common measures.
1 ton	1,000,000	2,204.6 pounds.
1 kilogram	1,000	2.204 pounds.
1 hectogram	100	3.527 ounces.
1 decagram	10	0.352 ounce.
1 gram	1	15.43 grains.

COMMON MEASURES AND THEIR EQUIVALENTS IN METRIC TERMS.

Length.

Common measures.	Meters.
1 mile	1,609.3
1 chain	20.1
1 rod	5
1 yard	0.91
1 foot	0.3
1 inch	0.025

Area.

Common measures.	Metric terms.
1 acre	0.4 hectare.
1 square rod	25.29 square meters.
1 square yard	0.836 square meter.
1 square foot	0.092 square meter.
1 square inch	6.45 square centimeters.

Capacity.

Common measures.	Metric terms.
1 cubic yard	0.76 cubic meter.
100 cubic feet	2.8316 cubic meters.
1 cubic foot	0.028316 cubic meter.
1 bushel	35.24 liters.
1 peck	8.81 liters.
1 gallon	3.78 liters.
1 quart	0.94 liter.
1 pint	0.47 liter.

Weight.

Common measures.	Metric terms.
112 pounds (cwt. long ton)	50.8 kilograms.
1 pound	453 grams.
1 ounce	28.35 grams.

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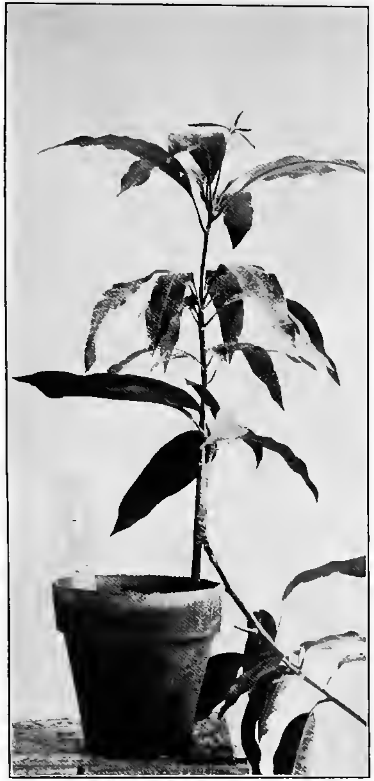
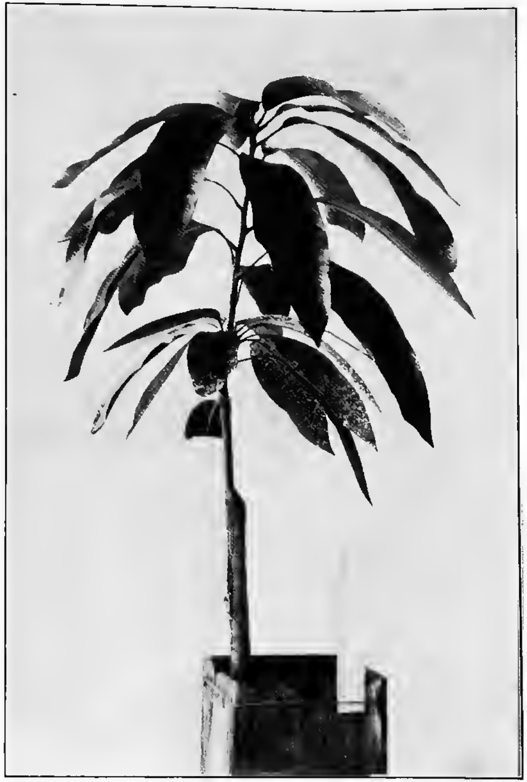


(*a*) INARCHING.



(*b*) INARCHED PLANT READY FOR THE FIELD.

A CRATE OF MANGOS READY FOR SHIPMENT.